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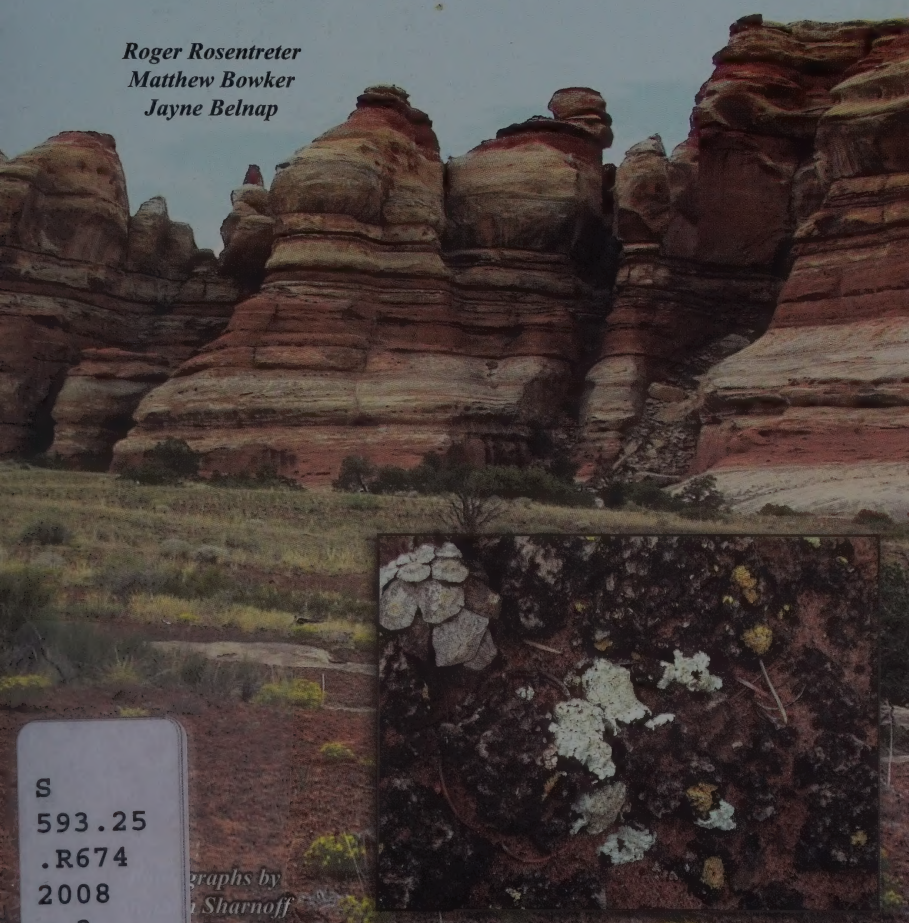
A Field Guide to Biological Soil Crusts of Western U.S. Drylands

Common Lichens and Bryophytes

Roger Rosentreter
Matthew Bowker
Jayne Belnap



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Sharnoff

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Roger Rosentreter, Ph.D.
Bureau of Land Management
Idaho State Office
1387 S. Vinnell Way
Boise, ID 83709

Matthew Bowker, Ph.D.
Center for Environmental Science and Education
Northern Arizona University
Box 5694
Flagstaff, AZ 86011

Jayne Belnap, Ph.D.
U.S. Geological Survey
Southwest Biological Science Center
Canyonlands Research Station
2290 S. West Resource Blvd.
Moab, UT 84532

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Design and layout by Tina M. Kister, U.S. Geological Survey, Canyonlands Research Station, 2290 S. West Resource Blvd., Moab, UT 84532

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How to use this guide

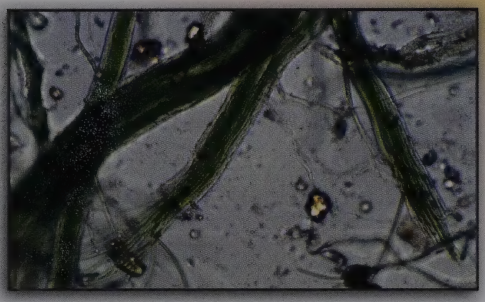
- This guide is primarily based on characteristics that can be observed in the field with the naked eye or a hand lens. Descriptions reflect 'typical' field appearance in North American drylands. The keys are constructed for dry material, while the full-page descriptions include colors when moist. Microscopic characteristics are included when they are necessary to aid in identification.
- Not all species in the keys have a full description. These species are treated under related species in the genus. When this is the case, the species name is followed by (ND), indicating it is not described on its own page.
- Distribution and elevation are indicated by areas shaded with yellow; when an entire area is yellow, this indicates that the species is present in all areas and/or at all elevations.
- Authorities are listed in the appendix for all species and synonyms.
- When a word or phrase is underlined in the description, that characteristic is critical in identification.
- Bold page numbers in the index indicate that a full description is included on that page for that species.

Introduction

Crust composition

Biological soil crusts (BSCs) are an intimate association between soil particles and cyanobacteria, algae, microfungi, lichens, and bryophytes (in different proportions) which live within or on top of the uppermost millimeters of soil. These communities have been known by a variety of names, including cryptobiotic, cryptogamic, and microbiotic soil crusts. They are found in all dryland regions of the world, including the polar regions, and in all vegetation types within these lands. In these landscapes, BSCs often cover all soil spaces not occupied by trees, grasses or shrubs and can comprise over 70% of the living ground cover.

Cyanobacteria

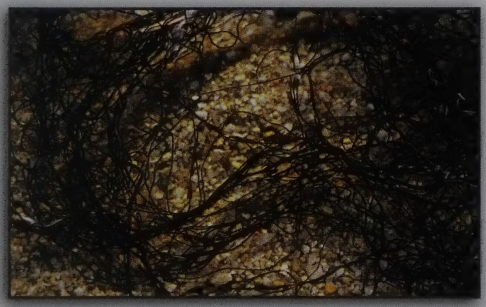


Large, filamentous cyanobacteria, such as *Microcoleus vaginatus*, provide most of the cohesion that holds biological soil crusts together. *Photo courtesy of USGS.*

The photosynthetic components of these crusts are dominated by cyanobacteria (formerly called blue-green algae), mosses, and lichens, with some green algae present as well. Cyanobacteria are one of the oldest known life forms. They were present in the oceans over 3 billion years ago and have existed on land for over 1 billion years. Cyanobacteria, particularly the large filamentous species, such as those in the genus *Microcoleus,* provide most of the cohesive quality of BSCs. In these species, many individual filaments are grouped together, surrounded by a sticky gelatinous sheath. These bundles of filaments wind throughout the uppermost soil layers, forming a net-like structure that binds together soil particles. This forms soil aggregates that create pathways for water infiltration and surfaces for nutrient transformations, while also increasing the soil's resistance to wind and water erosion.

Successional series

Once the large filamentous cyanobacteria stabilize the soil, single-celled cyanobacteria appear. Species of *Nostoc* are very common, growing both within and on top of the soil. When in the soil, the single cells often form a long thread of hollow round balls, surrounded by a gelatinous sheath. *Nostoc* can also form sheets that lie loose on the soil surface. Wind and water shred these sheets into hair-like vagrant threads. Other cyanobacterial genera commonly found in BSCs include *Schizothrix, Scytonema* and *Calothrix*. Unlike the larger cyanobacteria, these smaller species are fairly immobile and stay on the soil surface where they can obtain sufficient light. However, the soil surface also receives high amounts of ultra-violet light which can harm



Single-celled cyanobacteria, such as the *Nostoc commune* pictured here, are common on soil that has been stabilized by large filamentous cyanobacteria. *Photo courtesy of USGS.*

cellular structures. Thus, these smaller species contain high levels of UV-protective pigments, many of which are colored. Green algae (represented mainly by coccoid genera such as *Chlorococcum, Macrochloris,* and *Stichococcus*) can also be an important constituent of BSCs.

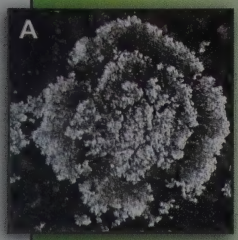
Scytonema myochrous is another common cyanobacterium found in biological soil crust. *Photo courtesy of USGS.*

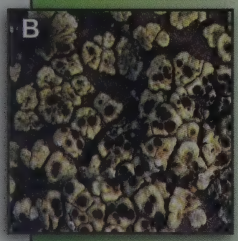
Lichens and mosses colonize after the cyanobacteria. Unlike cyanobacteria, lichens and bryophytes have almost all of their photosynthetic tissue on or above the soil surface. Both phycolichens (lichens with green algal photobionts) and cyanolichens (lichens with cyanobacterial photobionts) occur in a range of growth forms, or morphological groups. Crustose and areolate lichens cover the soil with an appressed and more or less even layer of thalli (*Buellia,* p. 49-50 and *Trapeliopsis*, p. 87-89). Squamulose lichens, such as *Psora* (p. 76-81) and *Placidium* (p. 73-74), have thalli divided into shield-, plate-, or scale-like squamules and thallus margins that are raised above the substrate. Foliose lichens are exemplified by species of *Peltigera* (p. 68). Fruticose lichens, which have cylindrical branches, are common in colder regions and are characterized by *Aspicilia hispida* (p. 46). Most soil lichens have a layered, or stratified, thallus. However, some cyanolichens have unstratified gelatinous thalli (e.g., *Collema,* p. 55-56). Annual short mosses (< 0.5 cm high; e.g., *Pterygoneurum ovatum* in some habitats, p. 21) and tall perennial mosses (0.5 to several cm high; e.g., *Syntrichia ruralis,* p. 23) also occur in soil crust communities. Most perennial mosses are also classified as short mosses (e.g., *Bryum argenteum*, p. 14). Thalloid and leafy liverworts (p. 25-28) occur in BSCs as well.

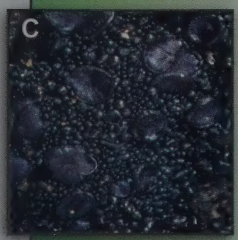
Ecological function

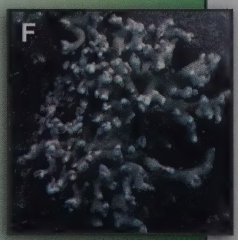
The presence of these organisms on the soil surface increases soil stability. Because they are photosynthetic they also contribute carbon to the underlying soils. Free-living and lichenized cyanobacteria can also convert atmospheric nitrogen into bio-available nitrogen, and thus are an important source of this often limiting nutrient. All these organisms also secrete compounds that increase the bio-availability of phosphorus. Lichen morphological types with a more discontinuous cover (crustose, squamulose) allow water, gases, and seedlings to pass through to the soil surface, whereas mosses and lichens with a more continuous cover (foliose, fruticose) often block the flow of materials to the soil surface.

Lichen morphology









Crustose (A, B) lichens form crusts that are so tightly attached to the substrate that they can't be removed without damaging the lichen or the substrate. Crustose lichens can be **continuous** (A) or **areolate** (B), appearing tile- or island-like and divided into small areas by cracks. **Gelatinous** (C) lichens have a single-celled structure of interwoven fungal threads with algae scattered between them and have a rubbery, jelly-like texture. **Squamulose** (D) lichens have scale-like lobes that are usually small and overlapping. **Foliose** (E) lichens have lobes that are somewhat leaf-like and are relatively loosely attached to their substrates. **Fruticose** (F) lichens are the most three-dimensional, usually forming cylindrical branches that can grow upward.

Because BSC organisms are only metabolically active when wet, as the amount of precipitation increases, so does the level of BSC development and lichen and moss cover. However, BSC cover is restricted in areas where vascular plant cover is high because BSC organisms have a limited ability to grow upwards from the soil surface and cannot compete for light. Thus, the most conspicuous development of BSCs occurs in hot, cool, and cold drylands where plants are widely spaced.

Soils

BSCs are found on almost all soil types. Green algae are favored on more acidic and less salty soils, whereas cyanobacteria are favored on alkaline soils and soils with high salt content. Within a given climate zone, the cover of lichens and mosses generally increases with higher clay and silt content and lower sand content, as this also increases the stability and water-holding capacity of the soil. However, BSC cover and development is limited on clay soils with a high shrink-

swell coefficient. Habitats within a site that are more moist (e.g., under plant canopies and thin plant litter or on north/northeast exposures) generally support a greater cover of lichens and mosses.

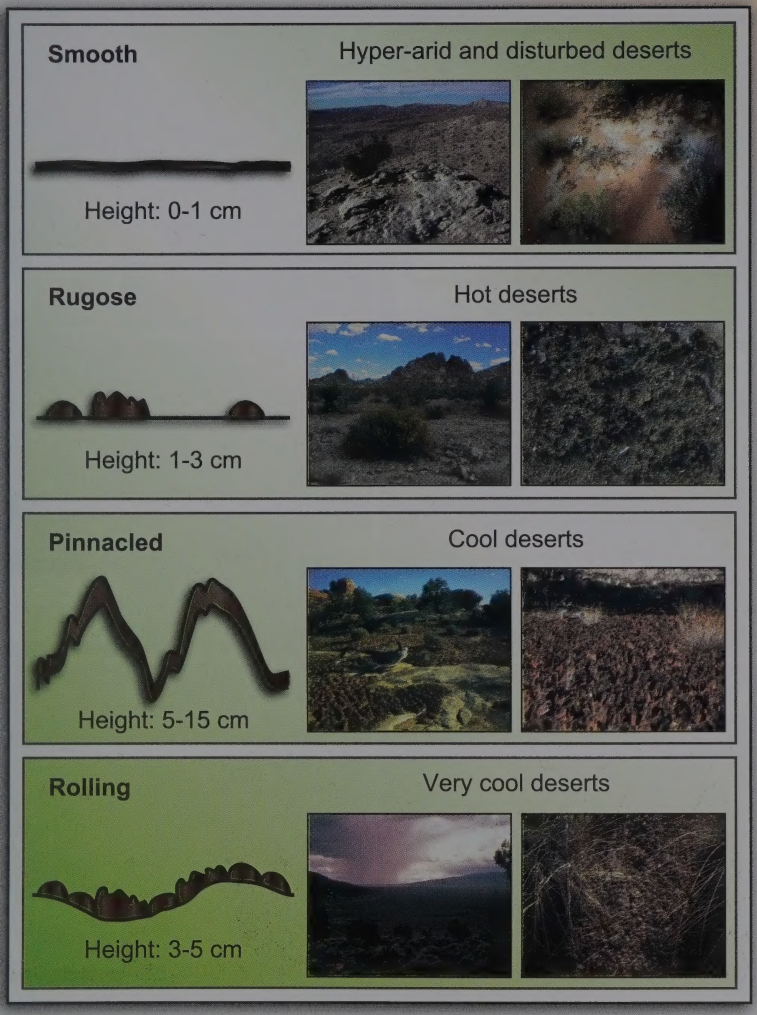
The external morphology of BSCs depends on climate, species composition, and disturbance regimes. The general appearance of BSCs can heavily influence ecosystem function by influencing how materials (e.g., water, seeds, plant litter, and nutrient-rich dust and soil) move across or are captured by the surface. Roughened surfaces slow material movement and increase the capture of resources, whereas a very smooth surface can have the opposite effect. Based on morphology, we define four categories of BSCs: smooth, rugose, pinnacled, and rolling. Smooth BSCs occur in hot deserts where soils do not freeze, and in recently disturbed areas. They are almost exclusively cyanobacteria, algae, and fungi. Chemical crusting is also common in this crust type. The other three BSC categories generally have lichens and mosses in addition to the cyanobacteria and fungi. Rugose BSCs have low surface roughness (< 3 cm) generally created by scattered lichen and/or moss clumps. Pinnacled and rolling BSCs are present only where frost-heaving occurs. Pinnacled crusts have up to 40% lichen-moss cover and can be up to 15 cm high. Rolling BSCs occur where high precipitation results in an extensive cover of lichens and moss, and the frost-heaving of these surfaces results in a gently rolling surface about 5 cm high. This classification is highly generalized, and all four categories are connected by intermediate crust types.

Monitoring

There are multiple approaches to the monitoring of BSCs, depending on the monitoring goals. Areas dominated by cyanobacteria can be divided into categories based on the darkness of the soil surface (p. 10, Belnap et al. In press), as darkness is an indicator of cyanobacterial biomass and soil stability. The number of categories chosen depends on how easily the categories can be distinguished from one another and the level of resolution needed to meet monitoring goals. For lichens and mosses, it is best to record cover by species if sufficient expertise is available. When this is not possible, recording the morphological group (e.g., crustose/squamulose/foliose/fruticose lichens, short/tall mosses) is best, as this provides information on soil stability, seedling establishment, hydrology, and carbon fixation. It is also useful to record phycolichens and cyanolichens separately, as this gives information on nitrogen contributions. If recording by species or by morphological group is not possible, the next best option is recording cyanobacterial darkness, as well as the presence of lichens and mosses (lichens are easily distinguished from mosses: when wetted, mosses turn brown or green, whereas lichens do not change much in color). It is also useful to record the morphological type of BSCs being monitored.

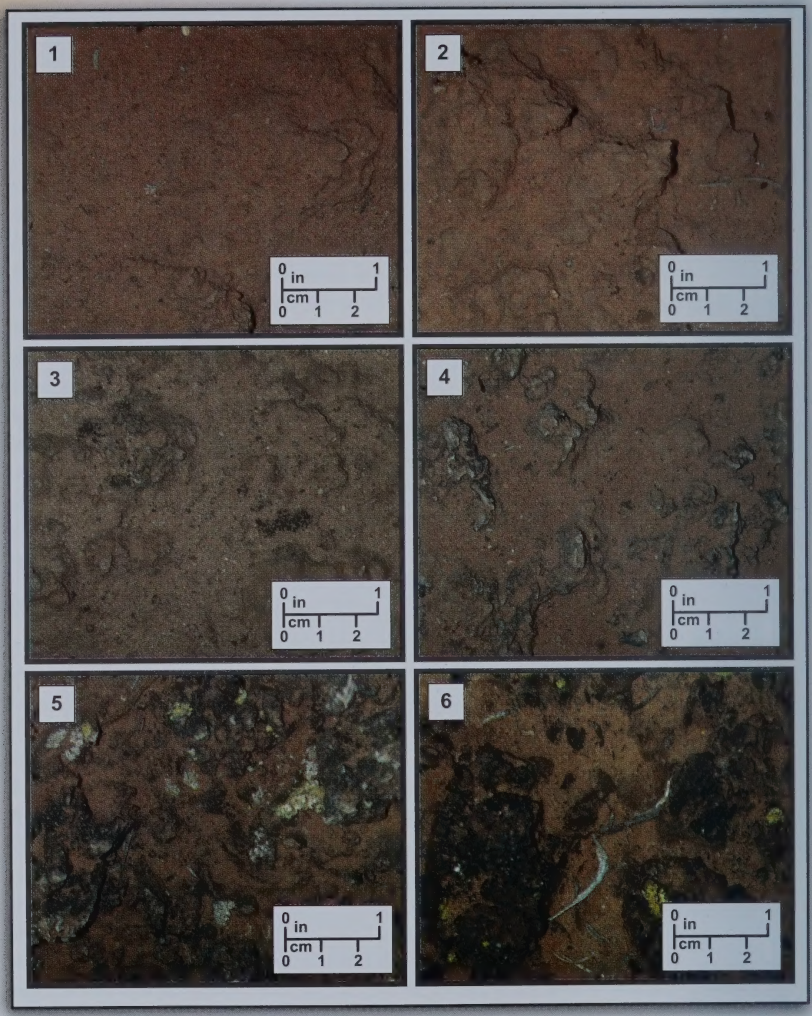
For more detailed information, see Additional Resources on p. 98.

Crust morphology



Smooth biological soil crusts (BSCs) occur in hot hyper-arid deserts, such as the Colorado Desert, and in recently disturbed deserts. Rugose BSCs occur in slightly less arid deserts, such as the Mojave Desert. Pinnacled BSCs occur in mid-latitude cool deserts, such as the Colorado Plateau. Rolling BSCs are present only where frost-heaving occurs in winter, such as in the Great Basin. *Photos courtesy of D.M. Miller and others, USGS.*

Monitoring BSCs using level of darkness



Biological soil crusts can be monitored using visually defined categories in areas dominated by cyanobacteria. These six categories were chosen for the Colorado Plateau (Belnap et al. In press). Tests showed these categories are easily distinguished by both trained and untrained observers and are closely related to cyanobacterial biomass and the resistance of the soil surface to wind and water erosion.
Photos courtesy of USGS.

1a) Upper leaves or entire plant white or silvery due to lack of chlorophyll, plants usually small (0.5 mm tall)..... ***Bryum argenteum*** complex

1b) Plants not whitish or silvery, plant size various **2**

2a) Plants generally bearing long (up to 8 cm), conspicuous, curved sporophytes with pear-shaped capsules; most common in the Great Basin and Columbia Basin ..... ***Funaria hygrometrica***

2b) Plants lacking long curved sporophytes..... **3**

3a) Plants lacking awns or ending in a short awn, light green to black..... **4**

4a) Plants light green, large (> 1 mm common), with tongue-shaped leaves (may be contorted when dry) and an abrupt, short point at leaf tip **5**

5a) Almost always bearing straight erect sporophytes (~ 1-2.5 cm tall); older sporophytes exhibit cylindrical capsules topped with a characteristic white column..... ***Tortula inermis***

5b) If sporophytes are present, shorter (< 1.5 cm); young sporophytes topped with characteristic dunce-cap-shaped calyptrae (~ 2-5 mm long) ..... ***Encalypta vulgaris***

4b) Plants darker; smaller leaves broadest below middle, not ending in a short point **6**

6a) When dry, dark green to black above and may be brownish below; tall (often > 3 mm) skinny plants with imbricate, approximately lance-shaped leaves; sporophytes rare ..... ***Didymodon vinealis***

6b) Olive green above and reddish brown below when dry; shorter plants with linear lance-shaped leaves (sometimes contorted, sometimes ~ imbricate); if present, mature sporophytes red with downward-angled capsules ..... ***Ceratodon purpureus***

3b) Plants with long awns (usually whitish and toothed), colors various..... **7**

7a) White awns longer than plant height; often appearing as white fuzzy tufts (plant buried or inconspicuous) ..... ***Pterygoneurum*** **spp.**
(Proceed to **8** if sporophytes are present)

ND = Not described in this book

8a) Plants green (~ 1 mm high); due to short setae, the sporophyte capsules are immersed in leaves or barely sticking out; calyptrae split in two or more places ..... ***Pterygoneurum subsessile*** (ND)

8b) Setae **longer**; sporophytes usually long and protruding; calyptrae split in only one place, often the awn is the only visible part ..... ***Pterygoneurum ovatum***

7b) White or yellowish awns, length less than plant height; plants are generally above ground and easy to see **9**

9a) Plants yellowish green or golden (mostly < 1 mm tall); awn a yellowish extension of an acuminate leaf tip, wider at base **10**

10a) Plants yellowish green, rarely in dense cushions, in arid areas ..... ***Bryum kunzei*** (ND)
(See description of *Bryum caespiticium*)

10b) Plants golden yellow with a magenta-colored stem (when wet), frequently in dense cushions; prefers shrub canopies in higher elevation areas ..... ***Bryum caespiticium***

9b) Plants light green or darker (not yellow), awn white and approximately the same width along its entire length **11**

11a) Plants light green or dark green; awn white, not toothed **12**

12a) Plants light green with long, tongue-shaped leaves (often > 2 mm when wet); sporophytes common in spring (~ 1.5 cm tall), with dunce-cap-shaped calyptrae ..... ***Encalypta vulgaris***

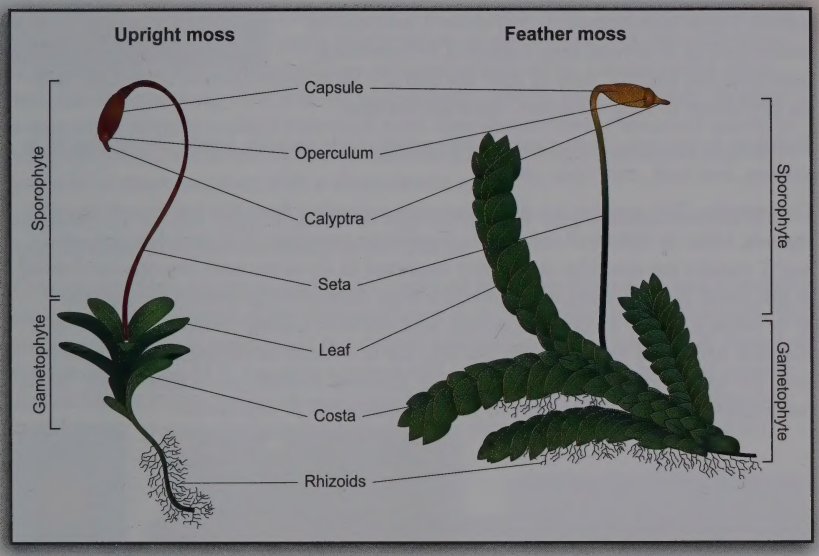
12b) Plants dark when dry, green when wet; leaves oval with unusually stout leaf mid-rib near leaf tip (when wet); sporophytes uncommon and lacking dunce-cap-shaped calyptrae ..... ***Crossidium*** **spp.**

11b) Plants lime green to blackish; awns white and toothed, reddish or brownish at base; sporophytes usually absent **13**

13a) Plants lime green to dark green at top, reddish at base, tall (often > 3 mm); leaves slightly twisted around stem when dry, squarrose to recurved when wet; leaf mid-rib frequently red ..... ***Syntrichia ruralis***

13b) Plants dark green to blackish at top, brown at base, small to medium (usually < 3 mm tall); leaves patent, not twisted around stem when dry; leaf mid-rib never red ....***Syntrichia caninervis***

Moss structure



Bryum argenteum

Common name: Silver-tipped moss

Synonyms: *Bryum argentum* There are over 90 additional synonyms.

Description: Plants upright, generally unbranched, silvery green to nearly white, especially in upper leaves. Stems bulb-shaped, 0.5 to about 1 mm tall but sometimes up to several mm. Leaves 0.5-1 mm long, imbricate wet and dry, may or may not end in a short point or short awn. Leaf mid-rib percurrent to long excurrent. Sporophytes rare.

Habitat: In the open and in areas with partial shade on soils, rocks, walls, cracks in cement, tree bark, roof tiles, etc.

Comments: This species is a true generalist occurring from the hot deserts to polar regions, often in disturbed areas. It is a common associate of *Syntrichia caninervis* and *S. ruralis* but could be reasonably expected to co-occur with any species treated in this book. *Bryum* is one of the world's most distinctive groups of mosses due to its white or silver color. It co-occurs with the very closely related *Anomobryum lanatum* which has more pointed leaf tips but is difficult to distinguish in the field, even for specialists. The leaf mid-rib of *A. lanatum* extends into a short point. Some researchers consider *A. lanatum* to be a subspecies of *B. argenteum*.

Large photo courtesy of Michael Lüth

Bryum caespiticium

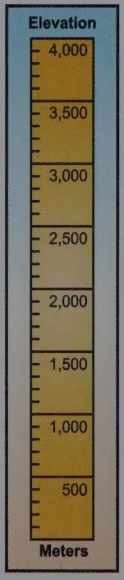
Common name: Dry calcareous bryum moss

Synonyms: *Bryum arenicola, B. symblepharum*. This species has 19 additional synonyms in the genus *Bryum*

Description: Plants upright, generally unbranched, dull yellowish leaves, green when dry, bright golden yellow when wet, forming dense tufts. Stems conspicuously bright red or magenta when wet, typically about 0.5-1 mm tall in arid regions but may be considerably taller. Leaves patent when wet, about 1 mm long. Leaf mid-rib well defined, usually long-excurrent, forming a smooth or slightly toothed yellowish awn. Sporophytes rarely observed except in very wet years. Seta is curved and terminates in an inclined to pendulous capsule, variable in shape and size, with a short slender neck.

Habitat: On various soils at middle to high elevations. Very common in cool deserts, confined to higher elevations in hot deserts.

Comments: This species is a common associate of *Syntrichia ruralis* and *Ceratodon purpureus*. Its yellowish color distinguishes it from most other aridland mosses. The small yellow *Bryum* common in hot deserts and the Colorado Plateau is *B. kunzei*, a former subspecies of *B. caespiticium* and still considered to be so by some experts. *Bryum kunzei* is also yellowish and awned but lacks a red stem, does not generally grow in dense tufts, does not have patent leaves when wet, and occupies drier regions.



Large photo courtesy of Michael Lüth

Ceratodon purpureus

Common names: Fire moss, puzzling moss

Synonyms: *Barbula saussuriana, B. validinervia, Ceratodon antarcticus, C. grossiretis, C. minutifolius, C. validus, Leskeela cuspidate, Meesia kenyae, Tortula saussuriana*

Description: Plants upright, generally unbranched, olive green above and reddish below when dry, younger tissue green when wet, mostly about 0.5-2 mm tall (up to a few cm) when mature, forming dense cushions. Leaves imbricate or sometimes twisted (in larger specimens) when dry, standing erect-patent when wet, usually about 0.5-1 mm long, but may be longer than 2 mm in large specimens. Leaf mid-rib strong, sub-percurrent to excurrent but awns are never present. Sporophytes uncommon in deserts but common in wetter regions. Setae yellow to dark reddish, 1-2.5 cm long. At maturity, sporophytes are distinctive based upon red color and capsules angled downward 90° from the seta.

Habitat: At middle to high elevations, especially in burned areas. Occurs in hot deserts but is confined to mountains in those regions.

Comments: This species is a common associate of *Bryum caespiticium* and *Syntrichia ruralis*. Throughout its entire range it is an extremely variable species. In the drylands treated here, its combination of relatively short stature, dense cushions, drab green color, and lack of awn distinguishes it, while the characteristic red sporophyte with angled-downward capsule make it instantly recognizable.

Inset photo courtesy of Matt Bowker.

Crossidium spp.

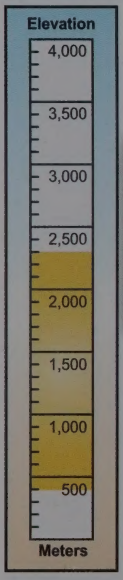
Common name: Tassel moss

Synonyms: *Crossidium aberrans: C. spatulaefolium; C. crassinerve: C. desertorum, C. erosum, Tortula crassinervia; C. squamiferum: Barbula squamifera, C. succulentum, T. squamifera*

Description: Plants upright, generally unbranched, brownish green or grayish green when dry, usually very small and inconspicuous (~ 0.5-1 mm tall, but up to 1 cm in large specimens of *C. squamiferum*), often forming grayish crusts created by dark dot-like plants against a background of lighter soil. Leaves oval-shaped, imbricate and recurved when dry, erect to patent when wet, about 0.6-1.4 mm long (up to 2 mm in *C. squamiferum*). Leaf margins are colorless only in *Crossidium squamiferum*. Leaf mid-rib appears to be very thick under a hand lens, occupying over half the width of the leaf in some species. Leaf mid-rib is always excurrent, ending in a shiny colorless awn. Sporophytes uncommon except in wet years.

Habitat: On dry soils, in shady places, or in the open. Common in warm deserts in general, especially abundant on gypsiferous soils (*C. seriatum*).

Comments: All *Crossidium* species share some growth of filaments on the inner leaf surface along the leaf mid-rib. *Crossidium* may be confused with *Pterygoneurum* which never has a patent leaf stance, has a longer and clearly white awn, frequently fruits in the spring, and is swollen at the base. *Pseudocrossidium crinitum*, common in the Chihuahuan Desert, has more lance-shaped leaves which twist around the stem.



Didymodon vinealis

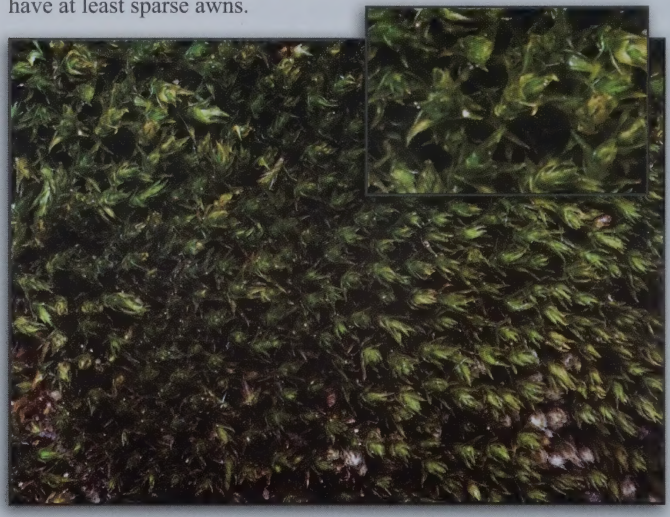
Common names: Screw moss, bearded moss

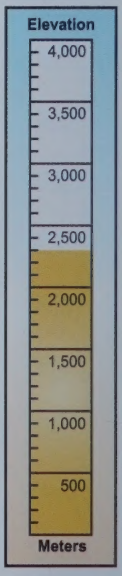
Synonyms: *Barbula chrysochaete, B. constricta, B. elbertii, B. fusia, B. leuhmannii, B. pachydictyon, B. rectifolia, B. subcontorta, B. subtorquata, B. torquata, B. vinealis, Didymodon insularis, Tortula insulana*

Description: Plants upright, often branched, nearly black above and brownish below when dry, upper tissue emerald green when wet, forming a dense cushion of slender plants up to about 2 cm tall. Leaves lance-shaped, imbricate when dry, erect when wet, not twisted or crisped, 0.8-2.5 mm. Awn lacking. Leaf mid-rib percurrent or ending shortly below the apex. Sporophytes rare.

Habitat: On various soil types in variable climate conditions. In deserts it occurs in sites that are shaded in the winter by shrubs or rocks. May also be found on coastal dunes.

Comments: This species is highly variable—the characteristics described here refer to its typical appearance in desert and steppe regions. Its tall slender stems, relatively small leaves, dark color, lack of awn, and densely packed populations distinguishes it from most other mosses. Other rarer *Didymodon* species (*D. trifarius, D. australasiae*) tend to be smaller plants in more sparse populations. *Syntrichia* species may be similarly colored but have a white awn. *Grimmia* species are typically found on rock and occasionally on soils but most have at least sparse awns.





Encalypta vulgaris

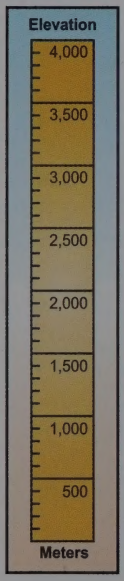
Common name: Common candle snuffer moss

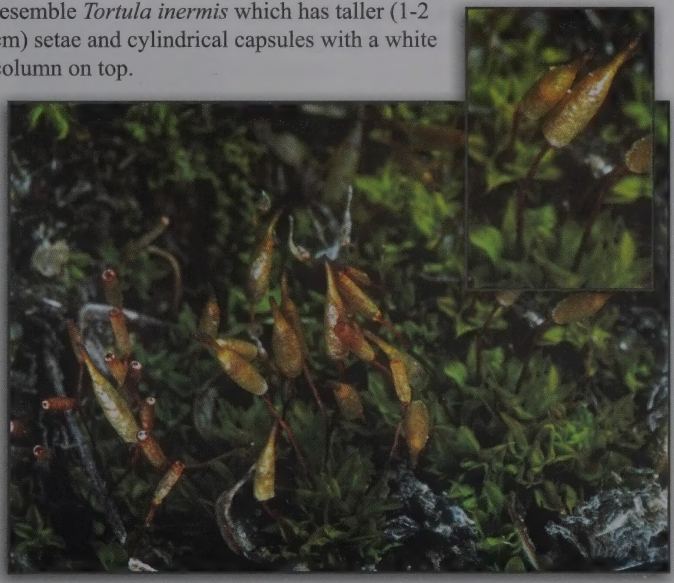
Synonyms: *Bryum extinctorium, Encalypta australis, E. extinctoria, E. novae-seelandiae, E. orsinii, E. pumila, E. tasmanica, Hymenostoma encalyptroides, Tortula mairei*

Description: Plants upright, generally unbranched except in unusually large specimens, upper younger tissue dull green when dry and light green when wet, brownish or reddish in the lower portion, usually 1-2 mm tall in arid regions but potentially several cm tall. Plants form loose cushions. Leaves very large (1-3 mm long) and tongue-shaped, widest above the center, strongly twisted when dry. Leaf mid-rib sub-percurrent or percurrent, ending in a short point or short, smooth, white awn. Sporophytes common. Setae 4-8 mm, straight, yellowish red. Calyptrae 2-5 mm, dunce-cap-shaped.

Habitat: Occasional in relatively mesic areas and microhabitats within dry areas.

Comments: The common name refers to the often observed large calyptrae. *Encalypta vulgaris* co-occurs and intergrades with *E. rhaptocarpa* which lacks awns, and these two can be difficult to tell apart. This species can be distinguished from *Syntrichia ruralis* by its shorter smoother awn, leaves which do not twist around the stem when dry, and frequent sporophytes with conical calyptrae. It may also resemble *Tortula inermis* which has taller (1-2 cm) setae and cylindrical capsules with a white column on top.





Funaria hygrometrica

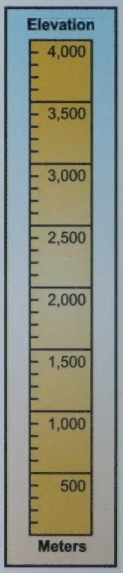
Common name: Cord moss

Synonym: None

Description: Plants upright, mostly short and unbranched, sometimes with 1-2(3) branches from the base, loosely tufted, or scattered. Younger tissue bright green, becoming duller with age. Upper leaves may form an oval, round, or bud-like cluster, especially in young plants. Lower leaves much smaller. Leaves, in general, are ovate, obovate to oblong, sharply pointed to acuminate, and may be twisted when dry. Leaf mid-rib usually slender, ending below the leaf tip to shortly excurrent, but not forming an awn. Sporophytes common. Long (1-8 cm), conspicuous, curved setae terminate in a pear-shaped capsule (1.5-2 mm) with a distinct neck. Setae are curved when moist and strongly twisted when dry.

Habitat: On soils, often in disturbed or burned sites, occasionally in rock cracks. Present in all North American deserts, but only common in the Great Basin and Columbia Basin. Confined to more mesic areas in warmer deserts.

Comments: An early colonizer, this annual species is dispersed by spores. May be an early colonizer after fires, primarily in cooler deserts. Along with *Ceratodon purpureus* and *Bryum argenteum*, this is one of the most cosmopolitan mosses in the world and can be instantly recognized when the conspicuous sporophytes are present.



Inset photo courtesy of Matt Bowker.

Pterygoneurum ovatum

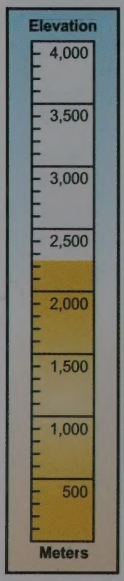
Common names: Ovate pterygoneurum moss, onion moss

Synonyms: *Barbula cavifolia, Gymnostonum pulvinatum, Pottia pilifera, Stegonia mouretii* var. *crinita*

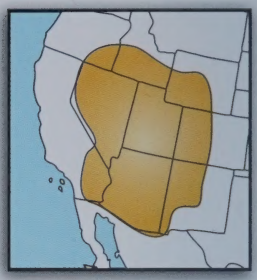
Description: Plants upright and unbranched, yellowish or brownish when dry, greening up somewhat when wet, minute and bulbous like miniature cabbages or onions. Plants may form dense hoary cushions or be scattered among other species. Stems often partially buried, up to 0.5 mm tall. Leaves erect or imbricate when dry, patent when moist, terminating in a very long (often > 3x the leaf length) white awn. Leaf mid-rib broad and strong. Sporophytes common in spring, long and protruding a few mm above the leaves. Calyptrae are split on one side.

Habitat: On various soils, often on well-drained soils.

Comments: *Pterygoneurum ovatum* is by far the most common species of the genus and is frequently found in warm aridlands and infrequently found in cool aridlands. *Pterygoneurum* is possibly the most distinctive genus of aridlands because the overall appearance often resembles a whitish tuft of awns with plants nearly invisible. It is a common associate of *Syntrichia caninervis*. Determinations within the genus require sporophytes and microscopic observations. *Pterygoneurum subsessile* is usually larger, has sporophytes with shorter setae scarcely protruding beyond the leaves, and calyptrae that split in 2 or more places. It may be very prevalent in disturbed areas.



Syntrichia caninervis



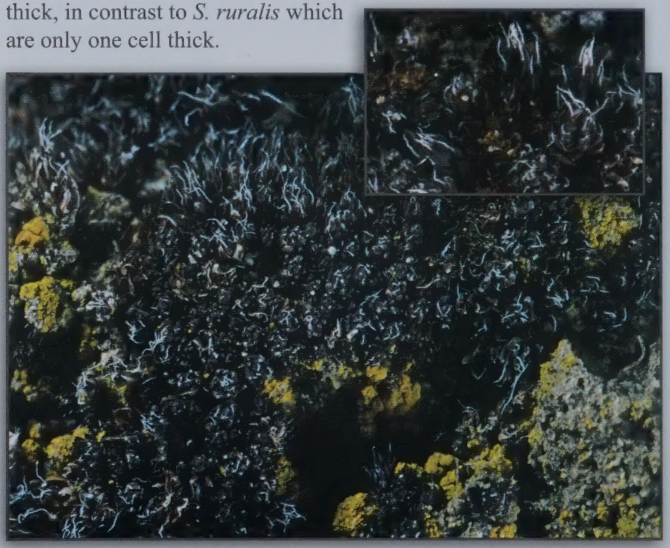
Common name: Short twisted moss

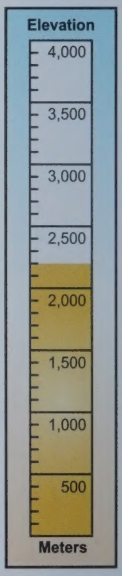
Synonyms: *Barbula caninervis, Tortula caninervis, T. desertorum, T. bistratosa*

Description: Plants upright, simple or branched, nearly black above and brownish below when dry, younger tissue green when wet, forming loose cushions. Stems typically about 0.5-2 mm tall but potentially much larger. Leaves imbricate and not twisted when dry, standing erect to squarrose when wet, typically about 1.0-2.0 mm long. Leaf mid-rib stout, dark reddish brown, excurrent and terminating in a conspicuous, white, toothed awn. Sporophytes rare but might be found in mesic microhabitats, resembling those of *Tortula inermis*.

Habitat: On various soils at low to middle elevations. Often dominant in hot deserts and the Colorado Plateau but largely replaced by *Syntrichia ruralis* in the Great Basin and Columbia Basin.

Comments: This species is frequently a dominant moss in drier warm deserts. It is a common associate of *Bryum argenteum* and *B. kunzei*. Its relatively large stature, white awn, and dark color easily distinguishes it. The closely related *Syntrichia ruralis* has leaves twisted around the stem when dry, is generally taller than 2 cm, is dull green above and reddish below when dry, and has a red leaf mid-rib. Under a microscope, the leaves of *Syntrichia caninervis* are two or more cells thick, in contrast to *S. ruralis* which are only one cell thick.





Syntrichia ruralis

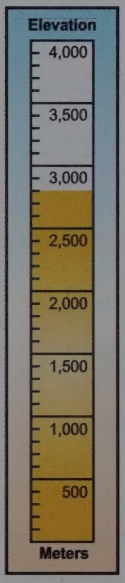
Common name: Twisted moss

Synonyms: *Barbula ruralis, Tortula longimucronata, T. ruralis*

Description: Plants upright, simple or branched, dull green to almost black above and reddish below when dry, upper part of plants bright green when wet. Plants forming loose cushions. Stems typically about 2-20 mm tall, sometimes up to several cm. Leaves twisted around stem when dry, squarrose to recurved when wet. Leaf mid-rib clearly red, terminating in a conspicuous, white, toothed awn. Sporophytes are rare, resembling those of *Tortula inermis* when present.

Habitat: On various soils at middle to high elevations, often in partial shade. May be dominant in cool deserts, common in the Sonoran Desert, and confined to mountainous regions in the Mojave Desert.

Comments: This species is a common associate of *Ceratodon purpureus* and *Bryum caespiticium*. It is among the tallest of biological soil crust mosses and, as such, likely plays distinct functional roles regarding hydrology and germination of vascular plant seeds. This, together with its twisted leaves and white awn, distinguishes it. *Polytrichum* species have rigid straight leaves which do not twist around the stem. The closely related *Syntrichia caninervis* is smaller, darker, thicker, and is generally shorter than 2 mm. *Syntrichia princeps* usually bears abundant sporophytes.



Tortula inermis

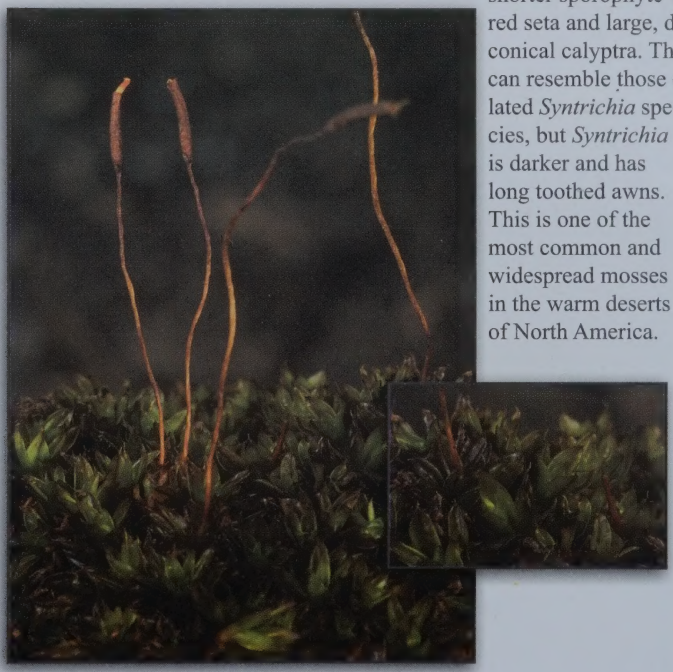
Common name: Hairless twisted moss

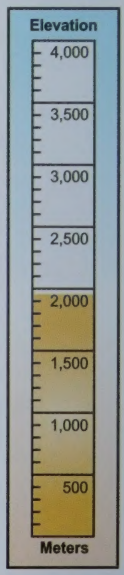
Synonym: *Syntrichia inermis*

Description: Plants upright, simple or branched, dull green, sometimes reddish in lower portions when dry, bright green when wet, forming loose cushions. Stems typically 0.5-1.5 mm tall. Leaves spiraling at the tips when dry and erect to patent when wet. Leaf mid-rib may be reddish and terminates in a short point or very short awn. Sporophytes common, reddish brown or darker at maturity, usually 1-2.5 cm tall. Capsules erect and cylindrical, when open bearing distinctive, white, columnar peristomes at the tip.

Habitat: At low to medium elevations in protected areas, particularly in the hot deserts.

Comments: This species is frequently observed in the partial shade afforded by rocks in the Mojave and other warm deserts. When wet, it may superficially resemble *Encalypta* species, but this taxon tends to occupy higher elevations and has a shorter sporophyte with a bright red seta and large, distinctive, conical calyptra. The sporophyte can resemble those of closely related *Syntrichia* species, but *Syntrichia* is darker and has long toothed awns. This is one of the most common and widespread mosses in the warm deserts of North America.





Liverwort Key

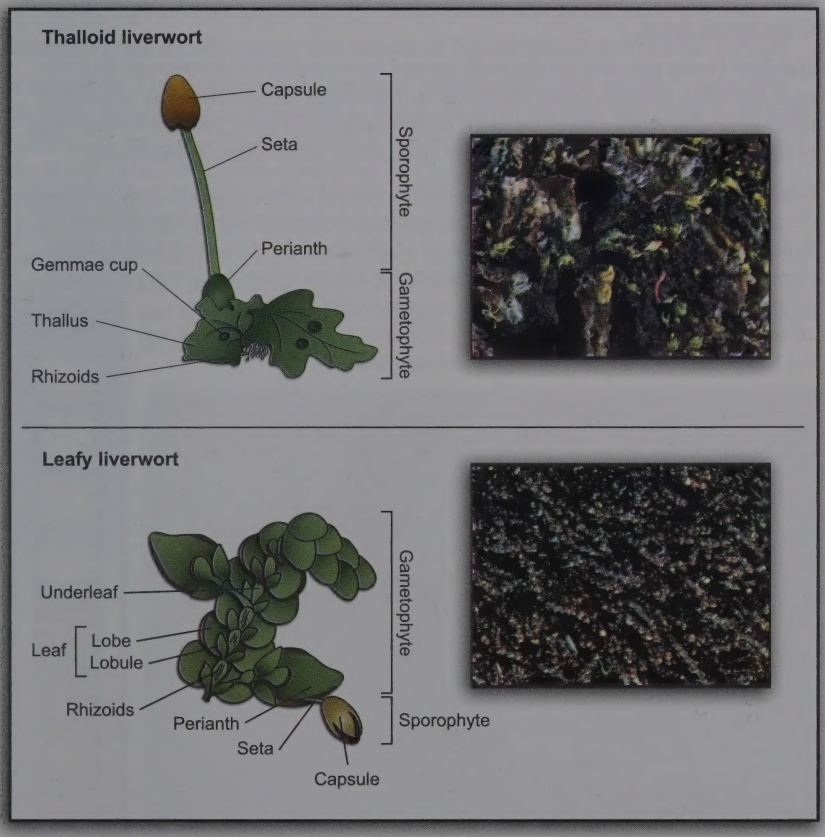
1a) Thallus leafy; a flattened, green, slender, leaf-like structure **2**

1b) Thallus thalloid; a minutely thread-like black structure with a series of minute leaves ..... ***Cephaloziella divaracata***

2a) Grayish green leafy thallus with a fringed purple margin.. ***Athalamia hyalina***

2b) Green leafy thallus with an entire green margin ..... ***Fossombronia longiseta***

Liverwort structure



Athalamia hyalina

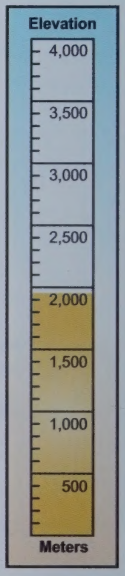
Common names: Athalamia, thalloid liverwort

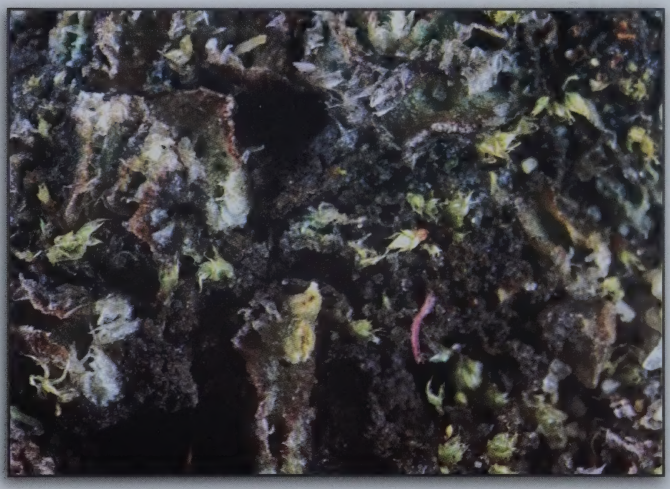
Synonyms: *Clevea hyalina, Plagiochasma erythrospermum*

Description: Plants thalloid, dioecious, grayish green, often tinged purplish at the margins, becoming blackish with age. Thalli small and fairly narrow (2.5-5.5 mm wide × 0.5-1.5 cm long), in irregular mats 4-7 cm across, not aromatic, delicate. Upper surface broadly and shallowly u-shaped or v-shaped in section, often disintegrating with age. Lower surface green or reddish. Rhizoids colorless. Sporophytes originating on the dorsal side of the thallus and not in the apical notch.

Habitat: Damp and slow-to-dry soils around rocks and at the margins of drainages and steep hillsides. Also infrequent in clay loams and silt loams in areas with ephemeral saturation. Can occur in or on the margin of vernal pools or on the edges of ponds. This species can occur in any arid habitat in the Great Basin Desert.

Comments: Vegetative plants can be distinguished by the combination of conspicuous, colorless or purplish, ventral scale appendages that usually extend beyond the thallus apex and lateral margin, and pores of air chambers surrounded by a single circle of cells. The entire thallus will close like a book when it dries up, making it difficult to see. More widespread than reports would suggest, *A. hyalina* is most obvious on moist spring days. *Riccia* species look similar but have smaller thalli and lack purplish margins.





Cephaloziella divaricata

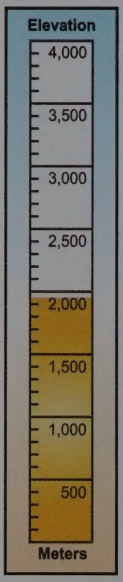
Common name: Common threadwort

Synonyms: *Cephaloziella starkei, C. confervoides, C. byssacea*

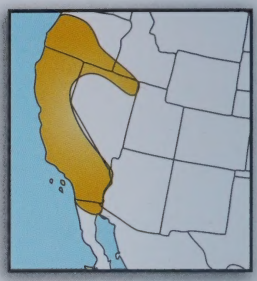
Description: Plants leafy, dioecious, black. Stems densely massed and thread-like, 3-10 mm long. Leaves numerous and distinct on both sterile and fertile stems, crowded near the shoot tips and deeply divided into two segments, about 2 mm long. Leaf lobes abundant, 2-celled. Gemmae reddish or purplish. Underleaves are narrow and undivided. Rhizoids can be numerous along the lower surface. Sporophytes rare. Perianth mouth almost uniformly purplish.

Habitat: Occasionally occurs with lichens on burned stumps as a pioneer species.

Comments: This species can be confused with *Cephaloziella rubella*—especially in sterile forms—but *C. divaricata* is distinguished by its wide leaf lobes (6-10 cells wide at the base) and small but distinct underleaves, in contrast to the monoecious *C. rubella* which has narrow leaf lobes (3-5 cells wide at the base) and no underleaves. Also, the perianths of *C. divaricata* are distinctly cigar-shaped, and the lower parts of the perianths are frequently purplish (colorless in the upper part), as indicated by MacVicar (1926). However, in *C. rubella*, the perianths are oblong and the upper parts of the perianths are purplish. In aridlands it is most abundant in pristine and old growth habitats, while it can be an early successional species in moist habitats.



Fossombronia longiseta



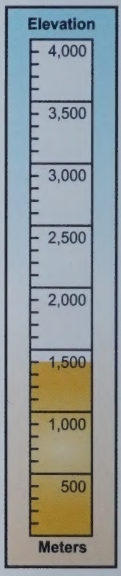
Common name: Annual leafy liverwort

Synonyms: *Androcryphia longiseta, Fossombronia kashyapii, F. vermiculata*

Description: Plants monoecious, leafy, green with crimson on the uppermost leaf margins and rhizoids only, forming irregular patches on damp sandy soils. Leaves deeply cut on both sides of a stem-like mid-rib into ruffed leaf-like lobes. Shoots up to about 5 mm long × 1 mm wide × 0.5-1.0 mm high. Rhizoids sometimes both crimson and colorless mixed on the same stem. Search for capsules at the apices of nearly fully elongated setae. Sporophytes club-shaped on a short stalk. Mature spores with ridges, 40-53 mm diameter.

Habitat: Open, sunny sites, often with recent but light disturbance of the soil surface. Generally on clay, silty and gravelly soils of hillsides, road banks, paths, and at the base of rock outcrops. Mixed with bunchgrass in warm grasslands.

Comments: Vegetative plants can exhibit great morphological variation on the same shoot during a single growing season, depending on moisture, sunlight, and maturity level. *Fossombronia longiseta* has spores with 30 or more lamellae, or spines, as seen in equatorial optical section with a compound microscope. In side view, spores have closely spaced lamellae 1.5-3.5 µm apart. Spores in capsules before setae elongation often have shorter lamellae and spine heights than spores in capsules with elongated setae.



Lichen Keys

Nomenclature follows Esslinger and Egan (1995) with a few exceptions. Lichens that commonly occur on soils as biological soil crusts are treated here. Lichens that normally occur on rock and occasionally or rarely occur on soils are not treated.

Major Division Key

1a) Thallus limited to growing on moss or organic debris ..... **On Moss-Key A**

1b) Thallus on various substrates..... **2**

2a) Thallus yellow, yellow-green (fluorescent) or orange..... **Yellow-Key B**

2b) Thallus other colors..... **3**

3a) Thallus blackish or brownish black, the foliose and fruticose species are gelatinous when wet, thallus non-stratified ..... **Black-Key C**

3b) Thallus another color or not apparent, the foliose and fruticose species not gelatinous when wet, thallus stratified **4**

4a) Thallus continuous or seemingly absent, crustose, with or without marginal lobes..... **Crustose-Key D**

4b) Thallus of discrete lobes, not crustose except for some lobate-margined crustose species **5**

5a) Thallus fruticose or 3-dimensional foliose ..... **Fruticose-Key E**

5b) Thallus otherwise..... **6**

6a) Thallus foliose..... **Foliose-Key F**

6b) Thallus squamulose, of discrete scale-like thalli, occurring in clusters..... **Squamulose-Key G**

A: On Moss

Thallus growing on moss or organic debris.

1a) Thallus narrow foliose, green to brownish with age; lobe margins often frosted with pruina; rhizines present, with many lateral branches; common growing over mosses in moist microhabitats ..... ***Physconia muscigena***
(See ***Physconia perisidiosa*** if sorediate)

1b) Thallus not foliose **2**

2a) Thallus commonly with apothecia **3**

3a) Thallus thick, generally white to cream or green (spores 1-celled) **4**

4a) Disks black; thallus thick, gray-green to whitish; apothecia sunken within the thallus ..... ***Megaspora verrucosa***

4b) Disks yellowish; thallus thick and warty, pure white to cream-colored; apothecia sessile; commonly growing over *Selaginella* (spike mosses) or detritus ..... ***Ochrolechia upsaliensis***

3b) Thallus thin to unevenly thick with thin areas (spores 2-celled, dark) **5**

5a) Thallus thin to very thin, generally dirty-gray; apothecia small (< 1 mm); disks black with a well-defined rim, at least when young (spores small, 11-16 × 6-8 µm) ..... ***Buellia punctata***

5b) Thallus thin to moderately thick, uneven in thickness (papillate); apothecia can be larger with age, often greater than 1 mm (spores larger, 18-24 × 8-10 µm) ..... ***Buellia papillata*** (ND)

2b) Thallus mostly lacking apothecia or apothecia lacking a margin and not round in outline **6**

6a) Thallus thick, gray to olive green; medulla C-, K+ red; surface warty with isidioid bumps and occasionally some soredia; common on moss clumps that grow on rock (*Grimmia* spp.) or on organic detritus; common in dry steppe habitats ..... ***Aspicilia mastrucata***

6b) Thallus thin to granular with warty sections, greenish gray, olive-brown or brownish, C+ pink (fleeting), K-; soredia granular or powdery, whitish to yellow-brown in color; apothecia occasional, eccentrically shaped in outline, more flexuose (wavy) and variable in color from pale pinkish to dark brown, without a margin ..... ***Trapeliopsis granulosa***

ND = Not described in this book

B: Yellow

Thallus on various substrates and yellow, yellow-green (fluorescent), or orange.

1a) Thallus light green or fluorescent greenish yellow to dull chartreuse **2**

2a) Thallus squamulose to continuous areolate; apothecia red-brown or black with a lecanorine margin; occasionally parasitic on *Diploschistes* but often free-living (spores colorless, 1-celled, < 1 µm) ..... ***Acarospora schleicheri***

2b) Thallus squamulose, scales dispersed to crowded, not at all a continuous areolate thallus; cortex UV+ dull orange; apothecia lacks a margin ..... ***Psora icterica***

1b) Thallus pale yellow, egg-yolk yellow, orange, or red-orange **3**

3a) Thallus egg-yolk yellow or pale dull yellow **4**

4a) Thallus continuous crustose to subfoliose, forming lobes adnate to the soil, yellow; small marginal lobes often present **5**

5a) Thallus subfoliose with obvious lobate margins (spores 2-celled) ..... ***Fulgensia desertorum*** (ND)

5b) Thallus crustose, less foliose, and less lobed (spores 1-celled) ..... ***Fulgensia bracteata***

4b) Thallus granular, not continuous, egg-yolk yellow; marginal lobes absent. ..... ***Candelariella citrina***

3b) Thallus whitish, pinkish orange, yellow orange, or red-orange **6**

6a) Thallus squamulose, white to pinkish orange to brick red, with upturned paler margins; soredia lacking; often on calcareous soils .. ***Psora decipiens***

6b) Thallus more crustose, bright orange to yellow orange; soredia present; on slightly calcareous soils ..... ***Caloplaca tominii***

C: Black

Thallus on various substrates, blackish to brown, greenish, or even gray; the foliose and fruticose species are gelatinous when wet, non-stratified.

1a) Thallus a thin black to dark brown crust of isidia or coarsely granular; apothecia rare, but if present are black with a black rim; photobiont green—scratched surface is a light green color (spores 1-celled) ..... ***Placynthiella* spp.**

1b) Thallus foliose (sometimes minutely so), photobiont blue-green when surface is scratched **2**

2a) Lobe margins with tiny white hairs; fairly common, often on soils and mosses ..... ***Leptochidium albociliatum***

2b) Lobe margins lacking tiny white hairs **3**

3a) Thallus dull and smooth or coarsely wrinkled under a hand lens, lacking a cortex; margins of lobes swollen or nodulose (with minute lumps) but not fringed; often with abundant isidia **4**

4a) Thallus small (< 2.5(3) cm diameter), foliose to subfoliose, weakly lobed if at all, often with isidia; apothecia often lacking (spores 2-celled) ..... ***Collema coccophorum***

4b) Thallus larger (1-6 cm diameter), foliose or lobate; isidia lacking to abundant; apothecia infrequent (spores 4-celled); widespread ..... ***Collema tenax***

3b) Thallus brownish black, slightly shiny and finely wrinkled under hand lens, with a cortex; lobes erect, margins of lobes finely fringed; isidia occasionally marginal; often in more mesic sites .. ***Leptogium lichenoides***

D: Crustose

Thallus on various substrates, continuous or seemingly absent, crustose with or without marginal lobes, not black or dark brown.

1a) Continuous crust, margins non-lobate **2**

2a) Thallus wholly sorediate, white, gray, or greenish ..... ***Lepraria* spp.**

2b) Thallus lacking soredia, various colors **3**

3a) Thallus with tiny embedded to immersed or sessile perithecia and greater than 0.2 mm diameter; appearing as discolored dirt growing on mineral soils ..... ***Thrombium epigaeum***

3b) Thallus with larger apothecia present **4**

4a) Thallus whitish to pale grayish, thin; colonies small (generally < 3 cm); apothecial disks blackish to olive-green, sometimes with yellowish or greenish tinge; rare and inconspicuous, most often found on decaying organic matter infused with soil as well as on old rabbit dung or on mineral soils ..... ***Texosporium sancti-jacobi***

4b) Thallus dirty cream or gray, usually thick; colonies can be large (2-12 cm); apothecial disks all black around the edges and sunken like a crater; very common on soils or growing over *Cladonia* spp. (spores becoming brown, many-celled, large) **5**

5a) Thallus thick with entire to smooth texture (spores 4 per ascus) .... ***Diploschistes muscorum***

5b) Thallus very thick, upper surface white and chalky (spores 4-8 per ascus) ..... ***Diploschistes diacapsis***

1b) Crusts with lobate margins **6**

6a) Thallus thin, white, continuous, strongly adherent to the soil; apothecia black; often on calcareous, silty soils ..... ***Buellia elegans***

6b) Thallus thick, uneven in thickness or nodular, white (occasionally brownish), strongly pruinose, areolate; apothecia brown or reddish brown to blackish; on calcareous soils and gypsum soils .....***Acarospora nodulosa*** var. ***nodulosa***

E: Fruticose

Thallus on various substrates and with discrete lobes, fruticose or 3-dimensional foliose.

1a) Thallus of two parts: basal squamules and erect, hollow stalks (podetia) **2**

2a) Podetia cup-shaped with tiny (generally < 1 mm) squamules inside (10x hand lens), frequently poor or lacking, sometimes appearing as a colony of scales; very common in dry habitats, especially in calcareous areas .... ***Cladonia pocillum***

2b) Podetia cup-shaped with soredia inside the cups .....***Cladonia fimbriata***

1b) Thallus of one part, podetia rare, reduced, or lacking **3**

3a) Lobes round in cross-section, not dorsiventral, olive, greenish, pale greenish, or tan to brownish; spores borne in apothecia but plants are usually sterile; rhizines lacking **4**

4a) Thallus free from the soil; branches dichotomous, short, thick, blunt; on calcareous soils **5**

5a) Thallus tipped with pale spots (pseudocyphellae) .... ***Aspicilia fruticulosa***

5b) Apothecia and pseudocyphellae lacking .....***Aspicilia aspera***

4b) Thallus at least partially attached to the soil **6**

6a) Thallus erect, basally attached; branches terete with laminal pseudocyphellae ..... ***Aspicilia hispida***

6b) Thallus more or less of compressed mats, attached at several points along the lobes, lacking pseudocyphellae **7**

7a) Thallus fruticose, branching in sections resembling beads on a string, with obvious lobes; on soils or organic matter **8**

8a) Thallus predominantly narrow, elongate and stringy; margins well defined, discrete; lobe tips sharply pointed and distinct from the main thallus, often black with forked tips, K- or weakly K+ ..... ***Aspicilia filiformis***

8b) Thallus more areolate and attached to the soil with only occasional stringy sections (resembling beads on a string); thallus margins poorly defined, diffuse; lobe tips similar in color and texture to main thallus, K- ..... ***Aspicilia reptans***

7b) Thallus crustose to areolate, with flat, discrete, areolate to somewhat convex lobes; on soils and rock ..... ***Aspicilia desertorum*** form ***terrestris***

3b) Lobes flattened in cross-section, dorsiventral, with margins strongly curled inward almost forming tubes, pale greenish to yellow-green; rhizines present ..... ***Xanthoparmelia chlorochroa***

F: Foliose

Thallus on various substrates, with discrete lobes, foliose or distinctly lobate crustose.

1a) Thallus sorediate, soredia terminal ..... ***Physconia perisidiosa***
(If soredia are marginal, ***Physconia enteroxantha*** (ND)

1b) Thallus not sorediate **2**

2a) Lobes greater than 2 mm wide, thallus greenish to gray **3**

3a) Lower surface with veins densely covered with dark brown hedgerows of rhizines ..... ***Peltigera rufescens***

3b) Lacking veins on the lower side, thallus white ..... ***Buellia elegans***
(Or see ***Acarospora nodulosa*** var. ***nodulosa*** in Key D: Crustose)

2b) Lobes greater than 2 mm wide, thallus brown ..... ***Massalongia carnosa***

G: Squamulose

Thallus on various substrates, of discrete scale-like squamules, occurring in clusters.

1a) Squamules pale greenish, gray-green, greenish black, or bluish black **2**

2a) Squamules sulfur green to greenish yellow ..... ***Psora icterica***

2b) Squamules whitish-gray to green or brown-green, not sulfur-green to greenish yellow **3**

3a) Squamules pale greenish, the edges free and usually upturned when dry, showing the whitish underside; apothecia borne on upright stalks..... ***Cladonia* spp.**
(See Key E: Fruticose)

3b) Squamules pale greenish or yellowish tinged, appressed, although the edges are often distinct; apothecia tan, more or less sunken in the thallus when young, becoming raised with time ..... ***Squamarina lentigera***

1b) Squamules some shade of white, gray, tan, brown, or blackish brown **4**

4a) Soredia present, similar in color to the thallus; thallus light gray; squamules small, appressed to ascendant, roundish to more or less elongate..... ***Trapeliopsis steppica***

4b) Soredia absent **5**

5a) Perithecia present, immersed in the thallus but ostioles are visible with a hand lens (10x) as small dark spots **6**

6a) Squamules often greater than 1.5 mm diameter, adnate, with conspicuous perithecia that have openings showing on surface of the thallus as slightly raised, larger, blackened spots (spores many-celled, brown)..... ***Endocarpon pusillum***

6b) Openings of perithecia relatively subtle in surface view, appearing as minute dark spots or essentially invisible without a hand lens (spores 1-celled, colorless) **7**

7a) Squamules with rhizines in a pale bundle..... ***Placidium lacinulatum***

7b) Squamules lacking root-like rhizines..... **8**

8a) Squamules with prominent, protruding, marginal pycnidia..... ***Placidium lachneum***

8b) Squamules with laminal pycnidia..... ***Placidium squamulosum***

5b) Apothecia present **9**

9a) Squamules with distinctly pale edges, either because the edges are more pruinose than the centers or because the edges are upturned, exposing the pale lower surface **10**

10a) Squamules pinkish orange to brick red, on calcareous soils ..... ***Psora decipiens***

10b) Squamules very dimple-shaped with a depression in the middle . ..... ***Psora crenata***

10c) Squamules some shade of brown or gray/pruinose over a brown thallus **11**

11a) Thallus large (squamules up to 10 mm wide); edges of squamules upturned, exposing the pale lower surface; usually associated with soils or mosses over rock or rock crevices .... ***Psora nipponica*** (ND)

11b) Edges of squamules pruinose, upturned or flat **12**

12a) Thallus light to dark brown; apothecia reddish brown; common on exposed, calcareous soils .... ***Psora tuckermanii***

12b) Thallus dark brown, whitish, or greenish tan; apothecia black **13**

13a) Apothecia marginal; on calcareous soils; ranging in color from chalky white (thickly pruinose) on highly calcareous substrates to a pale or greenish tan on more acidic substrates..... ***Psora cerebriformis***

13b) Apothecia laminal; squamules dark brown; edges raised, usually white/pruinose; uncommon, mainly in crevices in calcareous rock .... ***Psora himalayana*** (ND)

9b) Squamules not pale-edged **14**

14a) Squamules gray without an olive tinge; thallus C+ red, KC+ red; mainly west of the Cascade Mountains, common in California .. .. ***Trapeliopsis glaucopholis***

14b) Squamules gray, cream, olive, blue, or greenish black, with or without white pruina; thallus C-, KC-; widespread **15**

15a) Squamules blue, olive, or greenish black, with or without pruina; thallus C- **16**

16a) Squamules greenish black, epruinose; apothecia jet black; fairly common on soils and mosses ..... ***Toninia ruginosa***

16b) Squamules dark olive, blue, or grayish olive, whitish with dense pruina; apothecia dusty black; almost always present on highly calcareous exposed soils at all elevations..... ***Toninia sedifolia***

15b) Squamules gray, cream, olive or greenish black; with or without white pruina; thallus KC+ or KC- **17**

17a) Apothecia deep red to reddish brown (cut through apothecia to check the color) **18**

18a) Apothecia initially immersed but becoming sessile, never occupying the whole squamule..... ***Psora tuckermanii***

18b) Apothecia persistently immersed in squamules and eventually expanding to occupy most of the squamule; photobiont blue-green (cyanobacteria) **19**

19a) Squamules 1-3(5) mm diameter, brown to black; upper surface without a cortex; uncommon on soils but more common east of the Continental Divide ..... ***Heppia lutosa***

19b) Larger squamules (> 3 mm), occuring in colonies and lacking an upper cortex (not gray)..... ***Peltula richardsii***

19c) Squamules up to 8 mm diameter, brownish or olive to cream pruinose; upper surface with a cortex 8-50 µm thick. ***Heppia conchiloba*** (ND)

17b) Apothecia dark brown to black..... **20**

20a) Squamules with felty black rhizines (use hand lens), small, mostly about 1 mm or less, brown or grayish pruinose, appressed, the edges not upturned; medulla orange or yellowish orange ..... ***Phaeorrhiza sareptana*** (ND)
(See ***Phaeorrhiza nimbosa)***

20b) Thallus yellowish brown with a white medulla, occurring more frequently in alpine and subalpine habitats..... ***Phaeorrhiza nimbosa***

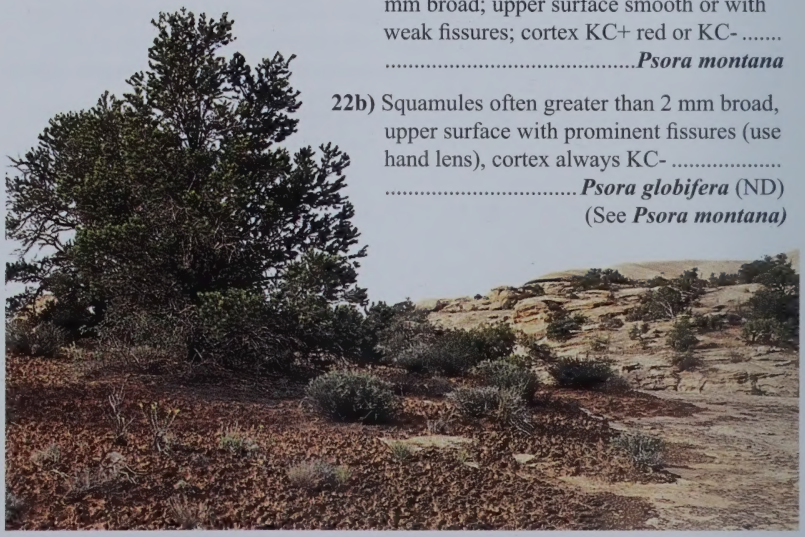
20c) Squamules mostly greater than 1 mm, brown to blackish brown or grayish to white pruinose, appressed or with edges free..... **21**

21a) Apothecia persistently marginal or between the squamules; thallus pale brownish, whitish pruinose, or dark brown; squamules developing a cracked upper surface or becoming thickly white pruinose; apothecia concolorous with the thallus, initially with a differentiated rim, though often losing it soon in development, flat to convex, round in outline, marginal; surface of apothecia K+ red, best seen with compound microscope; on calcareous sites forming whitish brain-like mounds (spores 1-celled) .... ***Psora cerebriformis***

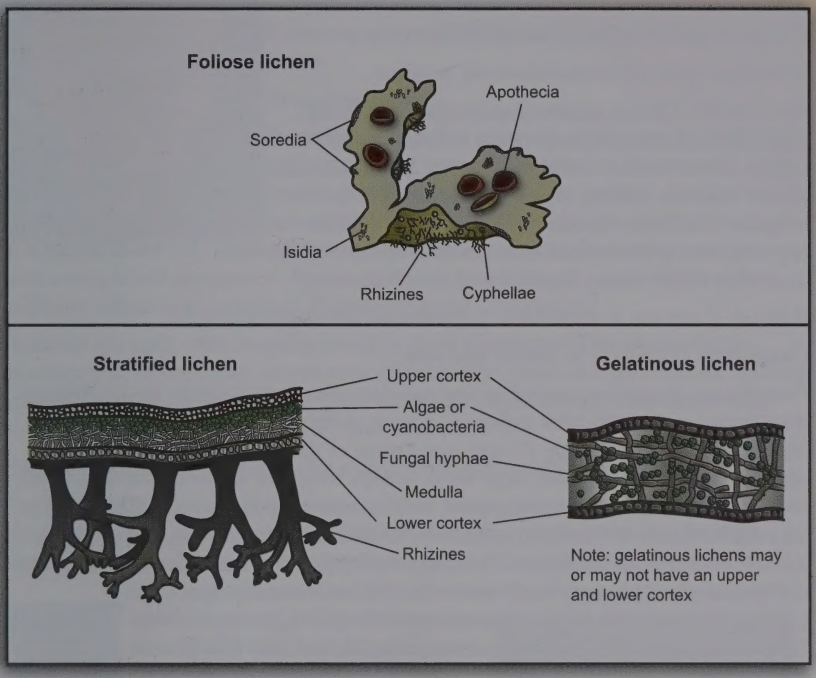
21b) Apothecia laminal, thallus brown to dark brown **22**

22a) Squamules relatively small, usually 0.5-2 mm broad; upper surface smooth or with weak fissures; cortex KC+ red or KC- ....***Psora montana***

22b) Squamules often greater than 2 mm broad, upper surface with prominent fissures (use hand lens), cortex always KC- ....***Psora globifera*** (ND) (See ***Psora montana)***



Lichen structure



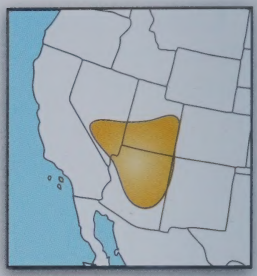
Lichen chemistry: spot tests

Certain chemicals react with lichen substances which are compounds (such as fatty acids) that occur in different locations on different lichens. "Medulla K+ yellow" means that if you moisten the medulla with K (potassium hydroxide), it will turn yellow. K/I indicates that first potassium hydroxide is applied, and then iodine.

Chemicals used for lichen spot tests:

Symbol	Compound
C	Calcium hypochlorite
I	Iodine
KI	Potassium iodide
K	Potassium hydroxide
N	Nitric acid
P	Para-phenylenediamine
UV	Longwave ultraviolet light

Acarospora nodulosa var. *nodulosa*



Common name: Nodule cracked lichen

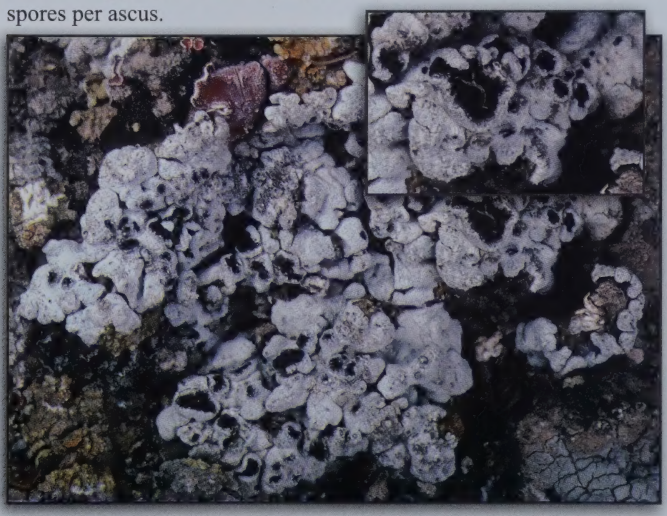
Synonym: *Acarospora nodulosa* var. *reagens*

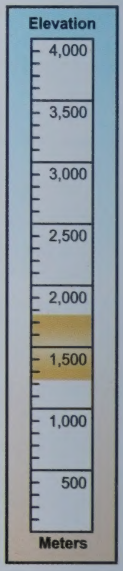
Description: Thallus squamulose/areolate, appearing white due to dense pruina, growing in a continuous colony. Lower surface tan to pale brown. Squamules lobate. Rhizines lacking. Apothecia common, round to irregular, 1-2(3) per squamule. Disks brown, reddish brown to nearly black, smooth to cracked. Spores small, more than 60 per ascus. Photobiont green (*Trebouxia*).

Habitat: Common to abundant on gypsiferous and calcareous soils.

Chemistry: Cortex C-, K- (usnic acid only).

Comments: *Acarospora nodulosa* var. *nodulosa* occurs exclusively on gypsiferous soils. It co-occurs with other gypsophiles such as *Psora decipiens* and *Fulgensia bracteata*, along with a very diverse assemblage of mosses and other lichens. It could be confused with other large white lichens with dark apothecia, such as *Psora cerebriformis, Diploschistes diacapsis,* and *Lecanora gypsicola*. *Acarospora nodulosa* var. *nodulosa* is clearly squamulose with lobate squamules and large, flat, immersed, brown-black apothecia. *Psora cerebriformis* has a brain-like, hemispherical thallus and small, convex, black apothecia. *Diploschistes diacapsis* is a thick, crustose lichen with numerous crater-like, dark gray apothecia. *Lecanora gypsicola* has a chinky, crustose thallus, and only 8 large spores per ascus.





Acarospora schleicheri

Common names: Schleicher's cracked lichen, soil paint lichen

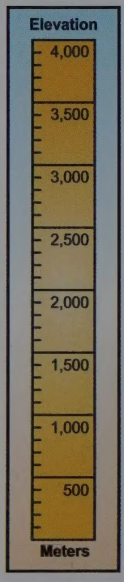
Synonym: None

Description: Thallus squamulose/areolate, pale to bright sulfur yellow to green, often lobed at the margins, sometimes whitish pruinose. Rhizines lacking. Apothecia red-brown, large, usually immersed in the thalli with round to irregular disks but occasionally somewhat prominent with lecanorine margins, with a roughened appearance. Spores dozens to hundreds per ascus, single-celled, colorless, ellipsoid to spherical. Photobiont green (*Trebouxia)*.

Habitat: On soils, often found growing in close association with *Diploschistes muscorum* or *D. scuposus*. *Acarospora* occasionally grows on *Diploschistes*, stealing the algal photobiont for itself and parasitizing the *Diploschistes*. This lichen is an old-growth indicator (McCune and Rosentreter 2007).

Chemistry: Asci K/I-; cortex UV+ orange (rhizocarpic acid).

Comments: This is the only common yellow *Acarospora* on soils. *Fulgensia* species also produce yellow to orange thalli on arid soils, but they can be identified, even when sterile, by their K+ deep purple reaction. On gypsum soils one can find the uncommon crustose lichen *Lecanora nodulosa* (syn = *L. reagens*) which is normally white pruinose but occasionally will be light green and is more granular.



Aspicilia aspera

Common name: Crustose coral lichen

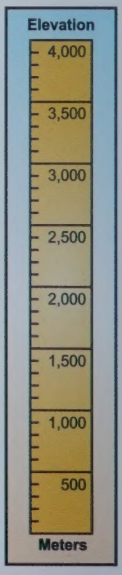
Synonym: None

Description: Thallus thick crustose to cracked and fissured or erect-fruticose, light tan or somewhat reddish (dependent on substrate color), sometimes resembles old chewing gum. Branches cracked, fissured and solid (1-2 mm diameter), more or less circular or somewhat irregular in cross-section. No pseudocyphellae or rhizines. Apothecia extremely rare, colorless. Spores single-celled, colorless, 9-40 × 2-20 µm. Photobiont green (*Trebouxia*).

Habitat: On limestone-derived or other highly calcareous soils.

Chemistry: KC+ yellow-orange (usnic acid only).

Comments: *Aspicilia aspera* is exclusively found on calcareous soils derived from limestone and red gypsum. *Aspicilia* species on soils can be very tricky to identify. *Aspicilia aspera* is best distinguished by its growth form and color. The more erect, narrowly branched, fruticose *A. hispida* is brown to green with pseudocyphellae appearing as conspicuous white spots on the thallus. *Aspicilia desertorum* form *terrestris* may be slightly fruticose on low carbonate soils but is more often a very fragile discontinuous whitish crust. *Aspicilia reptans* and *A. filiformis* have prostrate, creeping, fruticose growth forms and a more northerly distribution. *Aspicilia fruticulosa* is very fruticose and has white spots on the lobe tips.



Aspicilia desertorum form *terrestris*

Common name: Crusted aspicilia

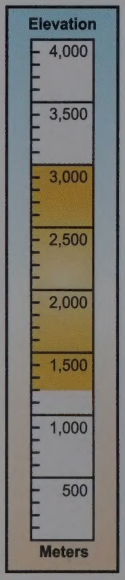
Synonyms: *Lecanora terrestrialis*, *L. desertorum*

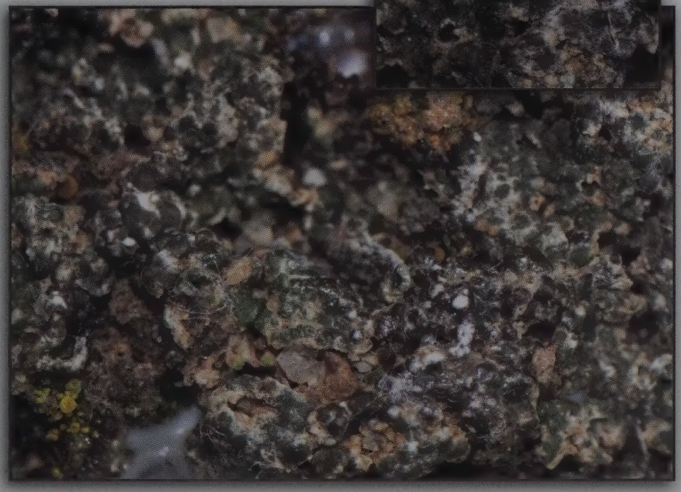
Description: Thallus crustose, thin chinky-areolate and discontinuous to more or less contiguous, white, whitish gray to gray-green, more or less pruinose, usually very fragile, at least partially attached to the soil. Apothecia very rare. Spores 8 per ascus, single-celled, colorless. Photobiont green (*Trebouxia*).

Habitat: Common on loamy to sandy soils Especially common on non-calcareous to mildly calcareous soils of the Colorado Plateau.

Chemistry: C-, K-, KC- or KC+ yellow-orange (usnic acid), P-.

Comments: This species may take on a very fragile, creeping, fruticose growth form on non-calcareous, very sandy soils where it can be very abundant. Sometimes it appears as if it is peeling away from the substrate. The form found only on rock is form *desertorum* and is more continuous crustose and is frequently fertile. *Diploschistes* species and *Aspicilia aspera* both have much thicker thalli which are more continuous crustose in *Diploschistes* and more erect fruticose in *A. aspera*. This species is distinguished from Great Basin/Columbia Basin species *A. reptans* and *A. filiformis* by being more adnate to the surface and having a very thin thallus. It was first described from the steppes of Russia.





Aspicilia filiformis

Common name: Ropy aspicilia

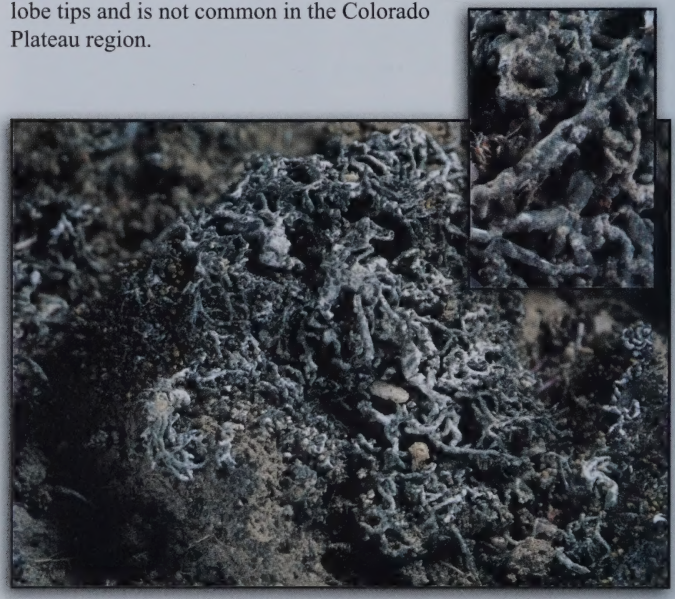
Synonym: None

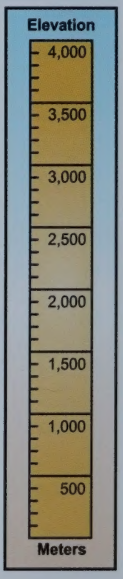
Description: Thallus fruticose, olive, brown, or greenish when dry, turning bright to dull green when moist, creeping and mat-forming, branching in sections resembling beads on a string. Thallus attaching at several points along the lobes—less than 50% of the thallus is attached. Rarely pruinose. Lobes discrete, elongate, and stringy, typically short (5-10 mm), contorted, and irregular in length, up to 15 mm long, 0.4-1 mm wide, terete. Lobe tips distinctly different from the main thallus branches, often black and forked. Apothecia rare, 0.4-1.5 mm diameter. Spores 2-4 per ascus, single-celled, subglobose, variable in size, about 18-26 × 16-24 µm diameter. Photobiont green (*Trebouxia*).

Habitat: On organic matter, soils, and in non-calcareous grassland habitats.

Chemistry: All spot tests negative.

Comments: This species is similar to *Aspicilia reptans,* but the thallus of *A. filiformis* is more fruticose, with narrower, more elongate and stringy lobes and well-defined margins. *Aspicilia californica* (C+ red) is similar but has less distinct lobe tips and is not common in the Colorado Plateau region.





Aspicilia fruticulosa

Common name: Coral lichen

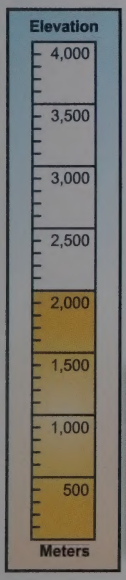
Synonym: *Lecanora fruticulosa*

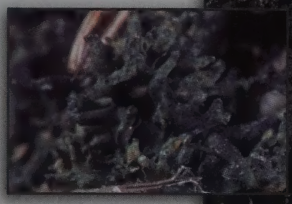
Description: Thallus fruticose, olive-green to brownish or gray, spherical, coarsely branched, 2 cm broad, free from the soil. Epruinose. Branches solid, more or less circular, dichotomous, very compact, short, thick (0.5 mm), blunt, tipped with conspicuous whitish pseudocyphellae. Apothecia rare, with a lecanorine margin, variable in size. Disks blackish. Spores 3-4 per ascus, single-celled, broadly ellipsoid to spherical, colorless. Photobiont green (*Trebouxia*).

Habitat: Rare to locally common, vagrant on calcareous soils in shrub steppes, occasionally growing with *Aspicilia hispida*.

Chemistry: Medulla K- or K+ red.

Comments: *Aspicilia hispida* has scattered pseudocyphellae and pointed lobe tips, in contrast to the blunt lobe tips of *A. fruticulosa*. Pseudocyphellae on *A. fruticulosa* are restricted to the lobe tips. The related species of *Aspicilia* are basally attached to the soil, humus, or rock substrate. In contrast, *A. fruticulosa* is always vagrant and produces distinctly globose thalli. Fertile *A. fruticulosa* specimens from Idaho and Utah have larger spores (30-20 × 25-15 µm) than other fruticose *Aspicilia* species.





Aspicilia hispida

Common name: Desert vagabond

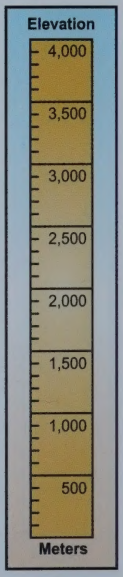
Synonym: *Agrestia hispida*

Description: Thallus fruticose, forming tiny, dull, olive-green to blue-green shrubby clumps up to 3 cm across, irregularly shaped, basally attached, erect, brittle, irregularly to dichotomously branched, with scattered laminal pseudocyphellae. Pseudocyphellae gray-green to yellowish gray. Branches short to elongate, terete to sometimes more or less flattened, tapering toward the edges. Lobe tips sharply pointed, solid, terete. Apothecia rare, sessile to short-stalked. Disks round to compressed, flat, smooth, dark gray, pruinose. Margins thick, persistent, smooth, concolorous with thallus. Spores 1-4 per ascus, single-celled, globose, colorless, large and variable in size. Photobiont green (*Trebouxia*).

Habitat: Over calcareous soils and pebbles in dry steppe. At first attached but often appearing vagrant when it is, in fact, attached to the soil.

Chemistry: All spot tests negative.

Comments: *Aspicilia fruticulosa*, a rarer member of this group, has white pseudocyphellae only on the branch tips (not laminally), and the tips are blunt rather than pointed. Vagrant species of *Rhizoplaca* and *Xanthoparmelia* are yellow-green (containing usnic acid in the cortex) and usually have flattened lobes.



Aspicilia mastrucata

Common name: Mossy aspicilia

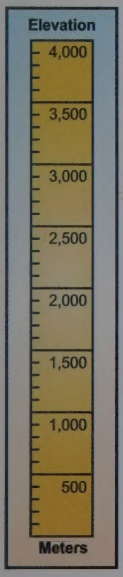
Synonym: *Lecanora mastrucata*

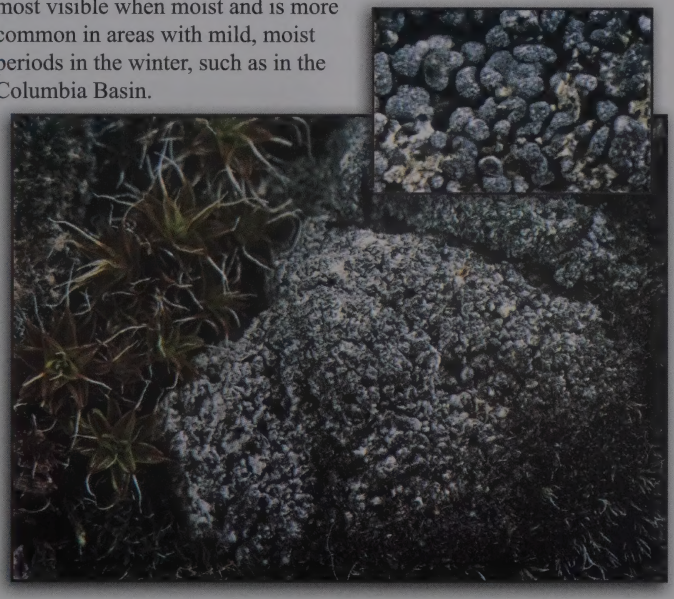
Description: Thallus crustose or prostrate with slightly erect fruticose lobe tips, olive green to brownish or gray, epruinose. Lobes up to 2 mm wide, solid, more or less circular or somewhat irregular in cross-section. Soredia occasional in irregular wart-like clumps. Cortex sometimes with pseudocyphellae. Apothecia rare with a lecanorine margin and blackish disk. Spores 4-8 per ascus, single-celled, 16-30 µm long. Photobiont green (*Trebouxia*).

Habitat: On mosses, soils, or old wood.

Chemistry: K+ red (norstictic acid), medulla C-.

Comments: This species has been overlooked by most ecologists and, when dry, is difficult to see. It is poorly known and collected in North America. Chemistry of this species is largely unknown but some are K+ red (often developing slowly). This species is mostly limited to growing over moss or other organic matter; even when found (rarely) growing on soils, the soil is high in organic matter. It is most often seen on clumps of *Grimmia* species that are growing on rock or shallow soils. It is most visible when moist and is more common in areas with mild, moist periods in the winter, such as in the Columbia Basin.





Aspicilia reptans

Common names: Creeping rimmed lichen, beaded string lichen

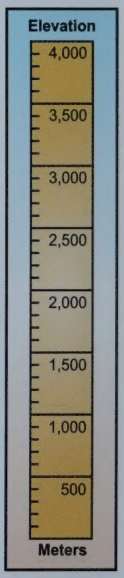
Synonym: *Lecanora reptans*

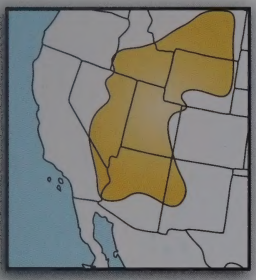
Description: Thallus fruticose, ranging in color from whitish to bluish gray, greenish when moist, looks like dead organic matter when dry. Sometimes pruinose. Areolae creeping and attaching at several points along the lobes. Lobes strongly convex or almost terete, clumped but not mat-forming, discrete, like beads on a string, 0.5-1.4 mm. Lobe tips not clearly differentiated. Lower cortex white with sparse, short rhizines. Less than 50% of the thallus is attached. Apothecia rare. Disks black. Margins sometimes absent, concolorous with the thallus. Spores 8 per ascus, single-celled, small. Photobiont green (*Trebouxia*).

Habitat: Shortgrass prairie, often on non-calcareous soils and organic matter.

Chemistry: All spot tests negative.

Comments: This species can be common in some sites and can form a continuous cover in pristine sites. It is very vulnerable to trampling. *Aspicilia filiformis* and *A. californica* (K+ red) are similar but have more distinct lobe tips and are not common in the Colorado Plateau region. *Megaspora verrucosa* has a similar color but is found on wood and organic matter and typically is fertile with deeply sunken apothecia, very large spores (> 30 µm), and a much thicker thallus. *Aspicilia mastrucata* often grows on mosses over thin soils or rock but rarely on soils.





Buellia elegans

Common name: Button lichen

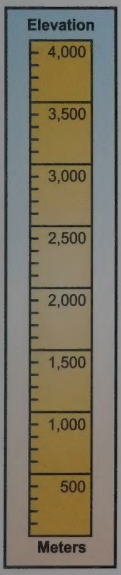
Synonym: None

Description: Thallus generally crustose, upper surface whitish pruinose, forming flat-lying rosettes up to about 2 cm diameter. Margins lobate and adnate. Lobes about 1 mm broad. Apothecia attached to the soil, black, lecideine, to 1 mm diameter. Apothecial margin concolorous with disk but at first with a thin, superficial, thalloid coating. Spores 8 per ascus, dark brown, mostly 2-celled, 13-18 × 6-9 µm. Photobiont green (*Trebouxia*).

Habitat: Dry, open, calcareous areas in grasslands and on soils in semiarid areas.

Chemistry: Thallus K+ dirty yellow, P-.

Comments: The spores are brown and 2-celled to rarely many-celled, and the apothecia lack a lecanorine rim. Externally, *Lecidea, Lecidella, Rhizocarpon,* and other genera in the Lecideaceae family are very similar but have different spores. This genus is differentiated by the above microscopic characters as well as the dark color of the hypothecium and epithecium, and thicker spore walls.



Buellia punctata

Common name: Tiny button lichen

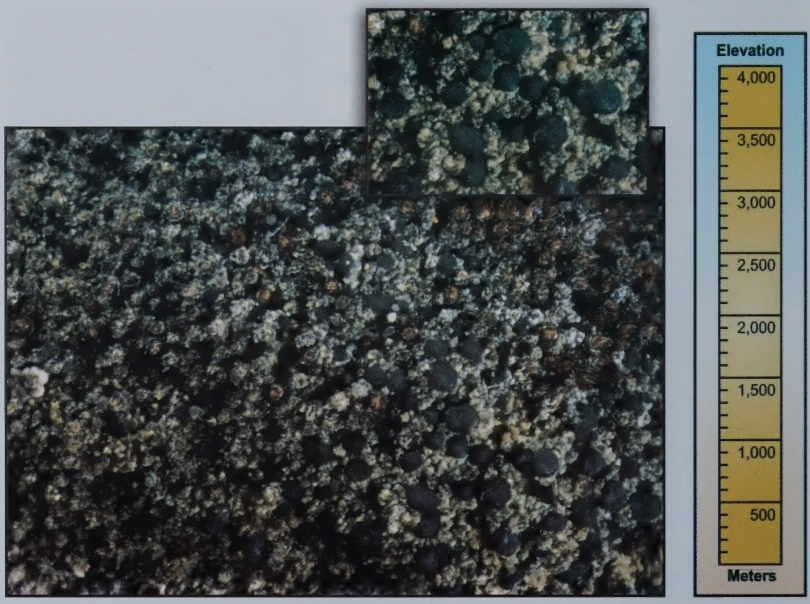
Synonyms: *Amandinea punctata, Buellia punctiformis*

Description: Thallus generally crustose, cracked or areolate, dirty gray to brownish, green when wet, thin and barely perceptible to moderately thick. Epruinose. Apothecia black, lecideine, 0.2-0.5 mm diameter, flat to convex. Margin thin and black, often disappearing in maturity, attached to the substrate. Exciple uniformly pigmented dark brown. Spores 8 per ascus, dark, mostly 2-celled (or more), 11-16 × 6-8 µm, cell walls not constricted. Photobiont green (*Trebouxia*).

Habitat: Twigs and bark of old wood are preferred habitats, but it can also be found on rock, soils and organic matter.

Chemistry: All spot tests negative.

Comments: *Buellia punctata* in aridlands is mostly found on organic matter, unlike *B. elegans* which is mostly found on calcareous soils. *Buellia punctata* is more frequent in old growth habitats and is an indicator of organic matter accumulation and lack of recent fire.



Caloplaca tominii

Common name: Tomin's orange lichen

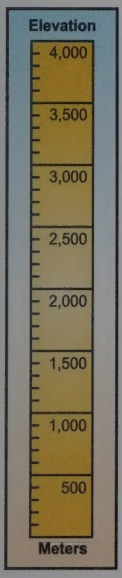
Synonym: None

Description: Thallus crustose, adnate, bright orange to yellow-orange. Thallus surface breaks into sorediа. Epruinose. Apothecia usually yellow to orange, 0.5-1.5(5) mm diameter. Margins usually lecanorine. Spores 2-celled, colorless, with a conspicuously thickened cell wall, pushing the cell cavities (locules) to the ends or "poles", therefore called polarilocular, 16-17 × 8-9 µm. Photobiont green (*Trebouxia*).

Habitat: On calcareous and slightly calcareous soils.

Chemistry: Thallus K+ purple-red or violet blue.

Comments: This species is easily determined by the mostly sorediate (powdery) surface of the thallus. *Caloplaca* species are generally more orange than yellow compared with the egg-yolk yellow lichens, such as *Candelariella,* which contain different pigments and are K-. The polarilocular spores are the confirming character, although in a few species, the cell wall is so thin that the spores resemble ordinary 2-celled spores. This species was originally described from the steppes of Asia and is an early successional species that can recolonize sites 1-3 years after fire and other types of disturbance. The presence of this lichen indicates that some calcium is in the soil—sometimes just a trace of calcium carbonate on the soil surface.



Candelariella citrina

Common name: Egg yolk soil lichen

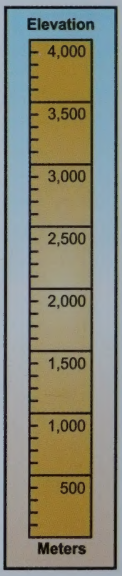
Synonym: *Candelariella terrigena*

Description: Thallus crustose or squamulose, varying from granular to areolate with slightly lobed areolae, more yellow than green, especially when dry. However, when wet it turns lightly green-yellow, often appearing as scattered yellow blobs on the soil, adnate, rarely forming lobed rosettes, often scanty, sometimes very scanty or growing only within the substrate. Epruinose. Lacking reproductive structures. Apothecia lecanorine, 0.4-0.7 mm diameter. Margins thin or thick, often discontinuous, thallus-colored. Disks yellow to brownish yellow. Spores 8 per ascus, colorless, ellipsoid, single-celled or, rarely, 2-celled (sometimes appearing to be 2-celled because of large oil drops), 14-18 × 6-8 µm. Photobiont green (*Trebouxia*).

Habitat: On soils, mosses, other lichens, organic matter, or dying vegetation.

Chemistry: C-, K- or K+ pale rose, KC-, P-, UV+ dull, dark orange (calycin).

Comments: Bright yellow species of *Acarospora* and *Pleopsidium* sometimes resemble *Candelariella*, but their apothecia are usually sunken into thallus areolae, and their asci generally contain hundreds of spores. Because they contain rhizocarpic acid instead of calycin, their UV fluorescence is much brighter orange.



Cladonia fimbriata

Common name: Trumpet lichen

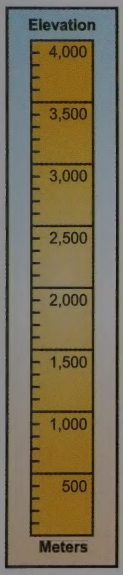
Synonym: *Cladonia major*

Description: Primary thallus squamulose, persistent, green to whitish gray. Squamules up to 6 mm long and 4 mm wide, lobe margins toothed to wavy, coarsely sorediate (especially under lobe margins). Podetia stalks sometimes breaking into masses of soredia. Stalks 6-30(40) mm tall, 1-2 mm wide, green to whitish gray, unbranched, with narrow, trumpet-shaped cups. Cups 2-6 mm wide. Margins entire or minutely toothed. Soredia abundant, flour-like, sometimes enlarging, later disintegrating and exposing the white medulla. Apothecia uncommon, brown, up to 1.5 mm in diameter. Spores 8 per ascus, oblong, single-celled, colorless, 8-14 × 3-4.4 µm. Pycnidia at cup margins, nearly globose. Photobiont green (*Trebouxia*).

Habitat: On soils or rotting wood, in sun or partial shade.

Chemistry: Thallus K-, P+ red (fumarprotocetraric acid).

Comments: *Cladonia fimbriata* must be carefully distinguished from *C. chlorophaea* by the presence, in the former, of powdery soredia more than one layer deep on the lower (external) portions of the cups; in *C. chlorophaea* the soredia are more granular and typically arranged in a single layer and the cups are more broadly flaring. The cups on *C. fimbriata* are longer and narrower than *C. chlorophaea* or *C. pocillum*.



Cladonia pocillum

Common names: Rosette pixie-cup, carpet pixie-cup

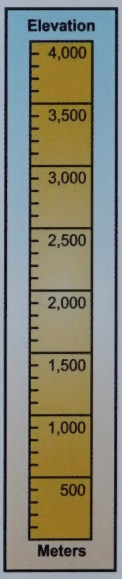
Synonym: *Cladonia pyxidata* var. *pocillum*

Description: Primary thallus squamulose, olive green to brownish green. Epruinose. Squamules persistent, crowded, large, thick, horizontally spreading, contiguous to overlapping, forming colonies of rosettes around the base of the podetia. Podetia are poor or lacking. When present, podetia originate from upper surface of primary squamules, short, cup-forming, or occasionally with marginal proliferations, grayish green to olive-green or becoming brownish. Cups initially narrow, becoming goblet-shaped; cup interior closed. Podetia and cups covered with small to coarse peltate squamules (umbrella-shaped and attached at the lower surface with a short stalk). Rhizines lacking. Apothecia rare, brown, along margins of cups, up to 3 mm wide. Spores 8 per ascus, single-celled, colorless. Photobiont green (*Trebouxia*).

Habitat: Very common in dry habitats, especially on calcareous soils. On soils and soils over rock, often in highly exposed, sunny and windy sites. Common in cooler sites within the Colorado Plateau.

Chemistry: Thallus C-, K-, KC-, P+ red; medulla UV-.

Comments: Basal squamules are always present and are greenish on the upper side and lighter to white on the lower side. They also have fruticose portions (podetia) that are erect but in some arid conditions are reduced and contorted.



Collema coccophorum

Common names: Tar jelly lichen, collema

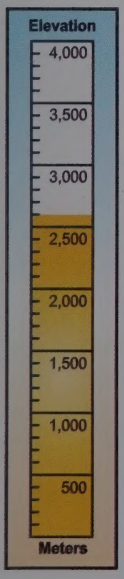
Synonyms: *Collema dubium*, *C. novomexicanum*

Description: Thallus gelatinous, non-stratified, minutely foliose or lacking foliose lobe margins, usually dominated by black, globose isidia. Epruinose. Forms hemispherical colonies up to about 3 cm diameter. Lobes 0.5-3 mm broad, 170-350 µm thick, when moist sometimes distinctly rosette-shaped. Apothecia uncommon, rimmed, brown, and more or less flat, 0.2-2 mm. Spores mostly 2-celled. Photobiont blue-green (*Nostoc*).

Habitat: On calcareous soils. This species of *Collema* is more common in the Colorado Plateau region and the Sonoran Desert than in the Great Basin.

Chemistry: All spot tests negative.

Comments: This is a nitrogen-fixing lichen. *Collema coccophorum* is commonly the dominant lichen on calcareous soils and commonly grows in a lime-loving community that includes *Psora decipiens* and *Placidium* species, although it is often found at lower densities on less calcareous soils. It co-occurs with *Collema tenax* which can be distinguished in the Colorado Plateau region and in the warm deserts by its attached rosette growth form and radiating lobes along the thallus margin. In the Columbia Basin, the two species may not be distinguishable by thallus morphology alone, but *C. tenax* predominates.



Collema tenax

Common names: Soil jelly lichen, collema

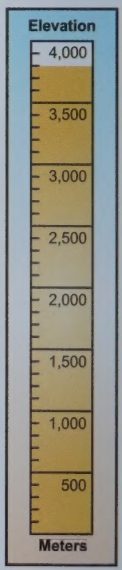
Synonyms: *Collema cristatellum*, *C. pulposum*

Description: Thallus gelatinous and minutely foliose or lobate, dark olive-green to black, often forming small, rounded or flat rosettes a few cm diameter. Thallus margins lobate and thicker near the terminus. Globose isidia resembling little balls may or may not be present, closely attached to partly curving up, dark olive-green to black. Apothecia infrequent, rimmed, reddish brown to brownish black, and more or less flat. Spores 2-8 per ascus, mostly 4-celled, colorless, 17-30 × 8.5-13 µm. Photobiont blue-green (*Nostoc*).

Habitat: On more or less calcareous soils.

Chemistry: All spot tests negative.

Comments: This nitrogen-fixing lichen is the most variable and most common species of this genus and attains the greatest abundance on mildly to moderately calcareous soils. On highly calcareous soils it tends to be less abundant than *C. coccophorum*. In warm desert and Colorado Plateau specimens, *C. tenax* tends to be less isidiate with radiating thalli in a rosette and has marginal lobes that are wider near the tip. *Collema coccophorum* has more erect thalli and is generally covered in bulbous isidia. In the Great Basin and Columbia Basin, *C. tenax* specimens may be virtually identical to *C. coccophorum*. However, spores of *C. coccophorum* are 2-celled.



Diploschistes diacapsis

Common name: Desert crater lichen

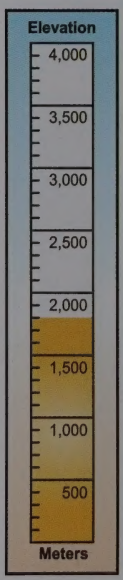
Synonyms: *Diploschistes albissimus, Urceolaria albissima*

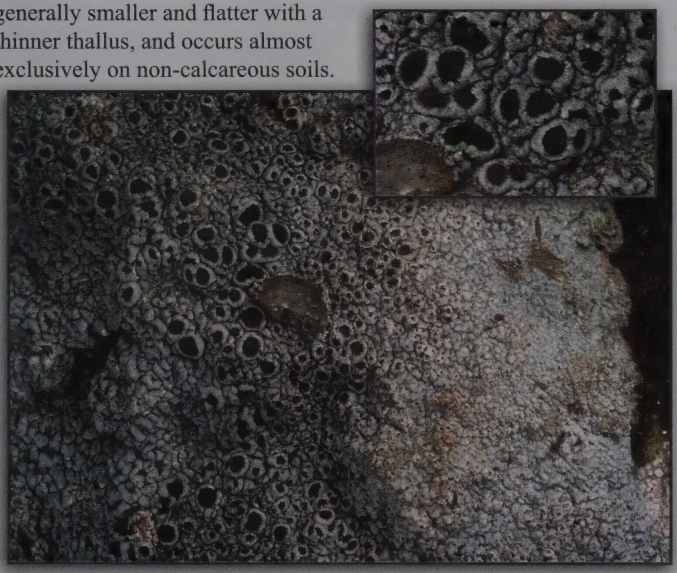
Description: Thallus very thick, crustose, light gray due to heavy pruina, often with an undulating appearance, greater than 5 cm diameter. Areolae up to 2.5 mm diameter. Rhizines lacking. Apothecia usually present, broad (up to 2.5 mm) and immersed, black or pruinose gray. Spores 4-8 per ascus, many-celled, 20-38 × 9-17 µm. Photobiont green (*Trebouxia*).

Habitat: Common on gypsiferous soils in the cool deserts, coastal Sonora and southern California grasslands and chaparral but may occur on various soils farther south and east.

Chemistry: C+ dark red, K+ yellow to purple, KC+ red, P-.

Comments: *Diploschistes diacapsis* is an excellent gypsum indicator in the Colorado Plateau region. It can occasionally form very impressive large populations and may dominate local areas. It typically co-occurs with *Psora decipiens*, *Fulgensia bracteata*, and *Squamarina lentigera*. *Diploschistes diacapsis* can be distinguished by its very thick (~ 2 mm), sometimes undulating crustose thallus and sunken rimmed apothecia. It looks similar to *D. muscorum,* which is epruinose, generally smaller and flatter with a thinner thallus, and occurs almost exclusively on non-calcareous soils.





Diploschistes muscorum

Common names: Cowpie lichen, crater lichen

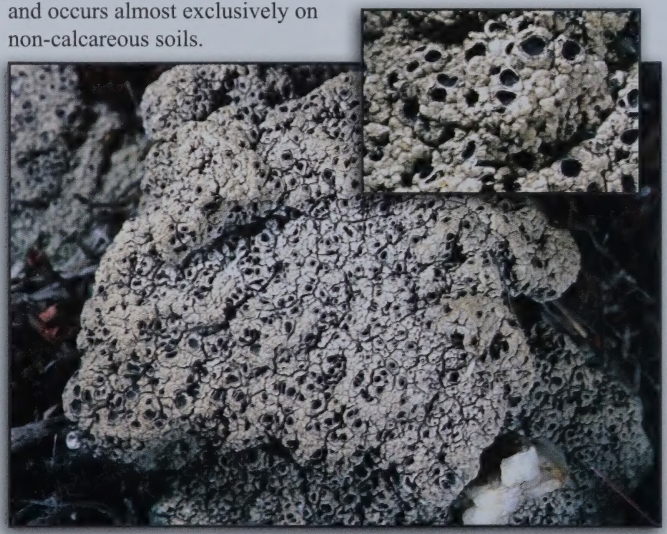
Synonym: *Diploschistes canadensis*

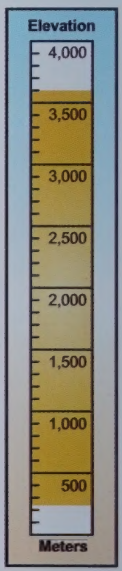
Description: Thallus crustose, light gray, flat to somewhat undulating or with a warty texture. Individual areolae usually less than 2 mm wide, often with margins only partially attached to the substrate, continuous, sometimes pruinose. Apothecia usually present, rimmed and sunken, less than 1.5 mm diameter and immersed, black or pruinose gray. Spores 4 per ascus, many-celled, large (18-32 × 6-15 µm). Photobiont green (*Trebouxia*).

Habitat: On non-calcareous soils and mosses or parasitic on *Cladonia* species.

Chemistry: C+ pink to red, K+ yellow to purple, P-.

Comments: *Diploschistes muscorum* is found throughout the North American aridlands, at all elevations and especially at northerly latitudes on non-calcareous soils and may also occur at rather low altitudes. It commonly co-occurs with *Cladonia fimbriata* or *C. chlorophaea,* which it may initially parasitize, and *Acarospora schleicheri,* which may parasitize it. *Diploschistes diacapsis* can be distinguished from *D. muscorum* by its very thick (~ 2 mm), undulating, crustose thallus, and preference for gypsiferous soils. *Diploschistes muscorum,* which is not pruinose, is darker gray and generally smaller and flatter with a thinner thallus and occurs almost exclusively on non-calcareous soils.





Endocarpon pusillum

Common name: Scaly stippled lichen

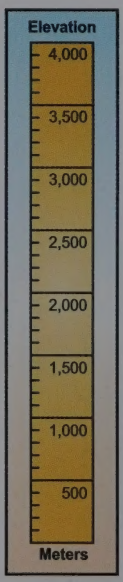
Synonym: *Endocarpon schaereri*

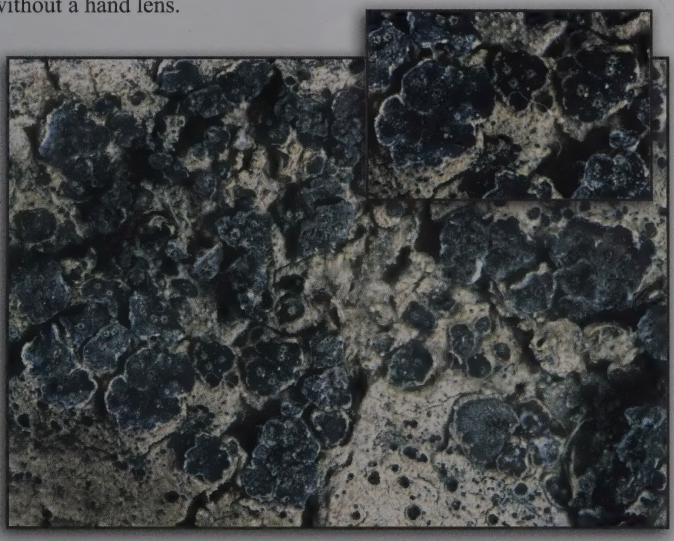
Description: Thallus squamulose, tan to light or dark brown. Epruinose. Squamules scattered to rarely contiguous, attached to the substrate to curving up at the edges, often greater than 1.5 mm diameter. Rhizines black, not apparent without removing the soil. Lower surface black or pale gray-brown. Soredia and isidia lacking. Perithecia common, immersed, dome-shaped, appearing as black wart-like structures, generally apparent only by a darkened ostiole. Spores 2 per ascus, many-celled, brown (rarely pale brown at maturity), 24-38 × 10-18 µm. Photobiont green (*Stichococcus*).

Habitat: On both calcareous and non-calcareous soils and rocks.

Chemistry: All spot tests negative.

Comments: The presence of algal cells in the perithecium and the many-celled spores immediately distinguishes *Endocarpon pusillum* from similar species of *Placidium*. The less scattered and more clustered specimens of *E. pusillum* can be mistaken for *Staurothele* which also has green algae in the perithecia but is truly crustose, having no lower cortex or upward-curving squamules. The perithecia in *E. pusillum* are larger and rise above the cortex more than they do in *Placidium* or *Catapyrenium* species. These perithecia are usually visible without a hand lens.





Fulgensia bracteata

Common name: Sulfur lichen

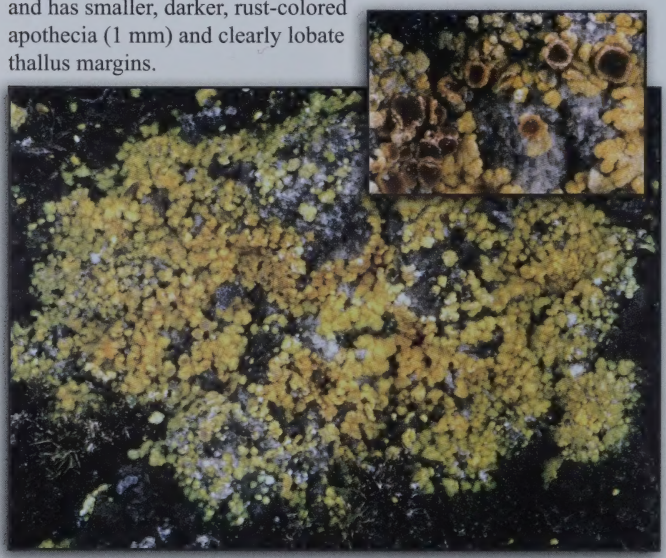
Synonym: *Caloplaca bracteata*

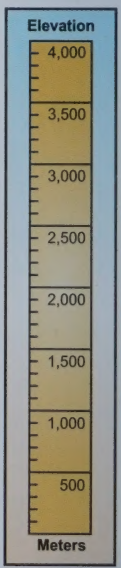
Description: Thallus crustose, granular to areolate, orange-yellow (parts may be white due to visible hypothallus), pruinose. Thallus margin lacks distinct lobes. Apothecia common, orange when mature, usually about 1 mm diameter. Spores single-celled, colorless, 11-15 × 5.5-8 µm. Photobiont green (*Trebouxia*).

Habitat: On calcareous soils and especially gypsiferous soils in cold desert or high elevation sites.

Chemistry: C-, K+ red or purple, KC-, P-.

Comments: *Fulgensia bracteata* is distributed from high to low elevations, including arctic tundra and cool deserts. In the arid regions it is occasionally found on calcareous soils but becomes quite abundant on gypsiferous soils where it co-dominates with *Psora decipiens*. *Fulgensia* species are continuous crustose and yellow, in contrast to the more foliose *Caloplaca* and *Candelariella,* which tend to be more orange and are much more fragile and may be discontinuous. The most abundant species of *Caloplaca* and *Candelariella* are often lacking apothecia. *Fulgensia desertorum* is similar but tends toward a paler yellow due to a white hypothallus, and has smaller, darker, rust-colored apothecia (1 mm) and clearly lobate thallus margins.





Heppia lutosa

Common name: Common soil ruby lichen

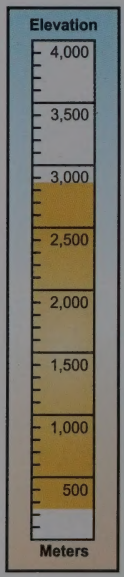
Synonym: *Solorinaria despreauxii*

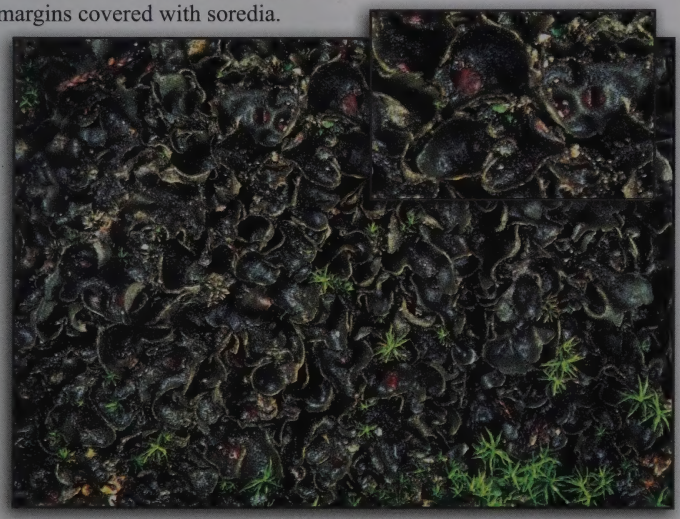
Description: Thallus squamulose, dark olive to brownish, circular in outline with the margins entire or becoming granular and irregularly toothed. Epruinose. Cortex well-developed, and some specimens have a loosely organized lower cortex. Medullary hyphae arranged vertically like a string of beads. Apothecia red-brown (ruby-red when wet), immersed in depressions in the thallus, sometimes very deeply concave. Spores 8 per ascus, colorless, single-celled, ellipsoid, about 20 × 10 µm. Photobiont blue-green (*Scytonema*), usually in vertical rows within the thallus.

Habitat: On limey soils, occasionally on soil in rock crevices and under overhanging rocks in desert and steppe.

Chemistry: All spot tests negative.

Comments: This is a nitrogen-fixing lichen. *Peltula richardsii,* which is very similar, has tiny, more numerous (> 60) spores per ascus and larger squamules (> 3 mm), occurs in colonies, and lacks an upper cortex (not gray). *Placidium* species contain green algae and have buried perithecia that show up as black dots on the surface. *Heppia lutosa* is generally darker olive than the gray *Placidium* species and often occurs as a single squamule, while *Placidium* species are always in small colonies. *Heppia conchiloba* has more upturned lobe margins covered with soredia.





Lepraria spp.

Common name: Dust lichen

Synonyms: *Lepraria zonata* and a dozen more

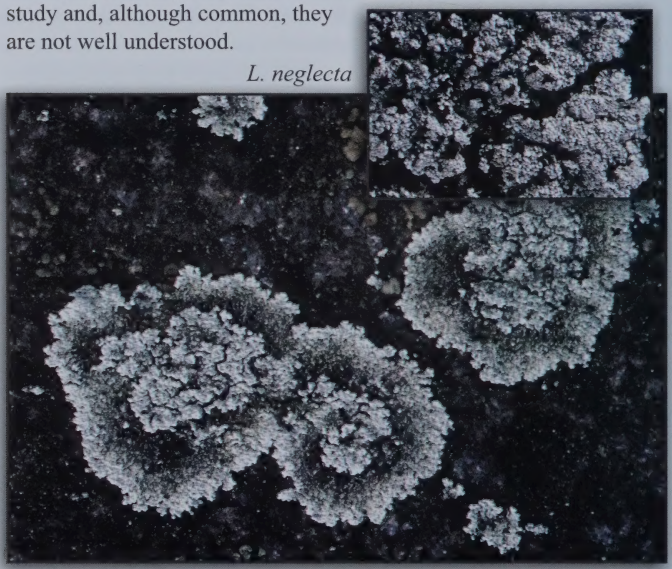
Description: Thallus crustose, blue-gray, gray, green, yellowish green, or white, coarsely granular sorediate, often forming distinctive rings or concentrically arranged in "zones" when growing on soils or rock. Thallus margins indistinct or, less commonly, clearly defined but without upward-curving lobes. Sterile, consisting of nothing but a continuous layer of soredia (actually, consoredia which are spherical, often fuzzy aggregations of a few individual soredial particles and look like very tiny cotton balls). Apothecia not present. Photobiont green (*Trebouxia*).

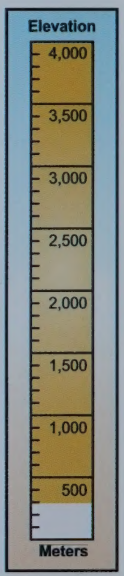
Habitat: On soil in shaded microhabitats, such as under or adjacent to grasses and shrubs, often on north-facing slopes at low elevations or in alpine tundra. Found only under overhanging rock in the Colorado Plateau region.

Chemistry: Variable by species.

Comments: *Lepraria* species are often confused with other genera of sterile soil crusts such as *Ochrolechia* and *Pertusaria.* This is a difficult group of lichens to identify and can, at times, be an early colonizer species in some habitats. Distribution by species is poorly known. This group of lichens needs further study and, although common, they are not well understood.

L. neglecta





Leptochidium albociliatum

Common name: Whiskered jelly lichen

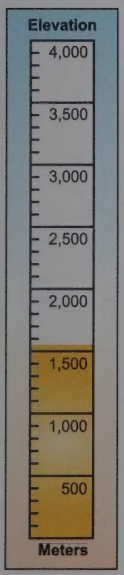
Synonyms: *Leptogium albociliatum, L. pilosellum, Polychidium albociliatum*

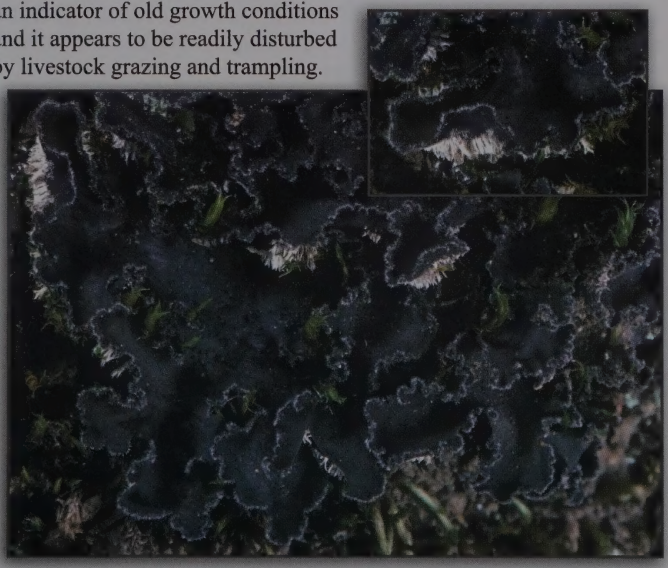
Description: Thallus foliose, gelatinous, greenish to slate gray to brownish black, weakly stratified with a middle layer of horizontal hyphae between two algal layers. Lobes 3-5 mm wide, with small but conspicuous white hairs abundant on lobe margins and exciple (10x hand lens), occasionally on the upper surface and isidia. Isidia present, granular to scale-like, occasionally cylindrical. Apothecia lecanorine, fairly common. Spores colorless, 2-celled, 18-26 × 5-9 µm. Photobiont blue-green (*Scytonema*).

Habitat: On mosses, soils or soil over rock, widespread, fairly common in moist to arid environments.

Chemistry: All spot tests negative.

Comments: This is a nitrogen-fixing lichen. *Leptochidium* superficially resembles some of the isidiate *Leptogium* species, such as *L. saturninum* and *L. burnetiae,* which have abundant white hairs on the lower surface. The stiff white "whiskers" on the lobe margins of *Leptochidium* distinguishes them. The presence of definite algal and medullary layers in the thallus is also diagnostic. In aridlands, it is an indicator of old growth conditions and it appears to be readily disturbed by livestock grazing and trampling.





Leptogium lichenoides

Common name: Tattered jellyskin

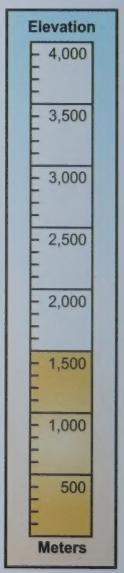
Synonym: *Tremella lichenoides*

Description: Thallus gelatinous (non-stratified), foliose, forming small, brownish black cushions. Lobes fairly wide (1-4 mm), wrinkled, upright, with edges that have finely divided, almost cylindrical, isidia-like outgrowths. Lobe tips erect, narrow (mostly 2 mm wide), grayish to brownish, lobulate or finely fringed. Upper surface generally with raised wrinkles visible with a hand lens (10x), interior of loosely interwoven hyphae. Rhizines lacking. Apothecia occasional, brownish red to black, concave, 0.2-0.7 mm diameter. Spores 4-8 per ascus, colorless, 4-celled to many-celled, 18-45 × 11-16 µm. Photobiont blue-green (*Nostoc*).

Habitat: On soils and among mosses.

Chemistry: All spot tests negative.

Comments: This is a nitrogen-fixing lichen. *Leptogium* and *Collema* have much in common and are sometimes difficult to distinguish in the field, especially when they are moist and swollen. However, *Leptogium* species do not enlarge when wet as much as *Collema* species. On the whole, species of *Leptogium* are grayer (often steel-gray) or more reddish brown when dry, with a smoother, more skin-like texture. *Collema* is never as shiny, probably because it has no upper cortex. *Leptogium lichenoides* is highly variable in form, but always has dissected lobes that have isidiate or fringed lobe margins.



Massalongia carnosa

Common name: Little-lobed lichen

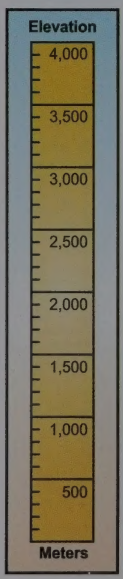
Synonym: *Pannaria carnosa*

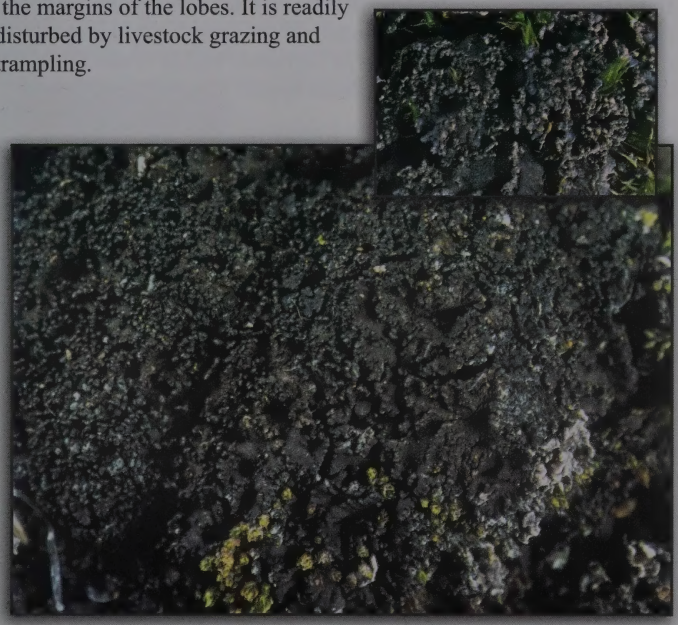
Description: Thallus foliose, isidiate to lobulate, a distinctive chocolate-brown color, rosette-forming. Upper cortex shiny when dry. Lobes foliose or subfoliose, up to 5 mm long. Margins distinctively finger-like, lobate. Marginal lobes similar in length and radiating out like fingers on a hand. Lower surface pale with sparse, dark rhizines. Apothecia rare, reddish brown to black, laminal or marginal, up to 2 mm diameter. Spores 8 per ascus, colorless, generally 1- to 2-celled, 11-27 × 4.5-8.5 µm. Photobiont blue-green (*Nostoc*).

Habitat: Moist sites, often on mosses and soils on north-facing slopes.

Chemistry: All spot tests negative.

Comments: This is a nitrogen-fixing lichen. Widespread but seldom common, this late successional species is less frequent in arid deserts than in the more moist Great Basin sites and grassland habitats. It is an old growth indicator in aridlands. It has a distinctive chocolate-brown color and, once seen, is easy to identify. It sometimes has pruina on the margins of the lobes. It is readily disturbed by livestock grazing and trampling.





Megaspora verrucosa

Common names: False sunken disk lichen, volcano lichen

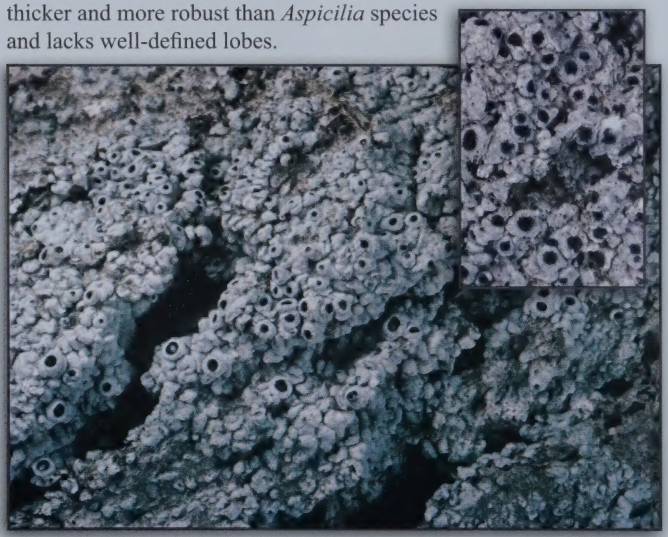
Synonyms: *Pachyospora verrucosa, Lecanora verrucosa*

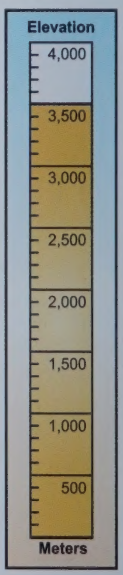
Description: Thallus crustose, gray-green to cream, thick, more or less densely white-pruinose, continuous or more or less dispersed in irregular patches. Apothecia with black, mostly sunken disks, 0.5-1.5 mm diameter, sometimes lecanorine with a thick margin. Spores 8 per ascus in two rows, colorless, single-celled, ellipsoid, thick-walled, 30-65 × 16-36 µm. This genus is named for its large spores. Photobiont green (*Trebouxia*).

Habitat: Widespread but infrequent on soils and mosses, especially in calcareous habitats. It occurs from deserts to microhabitats in forests of all kinds and into the alpine and talus slopes. Always on organic substrates.

Chemistry: All spot tests negative.

Comments: When sterile, *M. verrucosa* looks like *Diploschistes* which is C+ red, or *Aspicilia* species which can also be C+ red. This large-spored species is distinctive from similarly colored *Aspicilia* species due to the much larger spores and much broader habitat preference. It also has thicker spore walls and abundantly branched paraphyses. The *M. verrucosa* thallus is also much thicker and more robust than *Aspicilia* species and lacks well-defined lobes.





Ochrolechia upsaliensis

Common names: Saucer lichen, cudbear

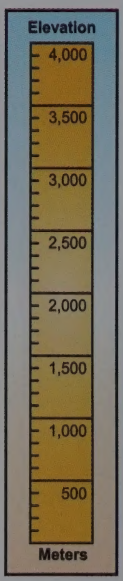
Synonym: *Psora upsaliensis*

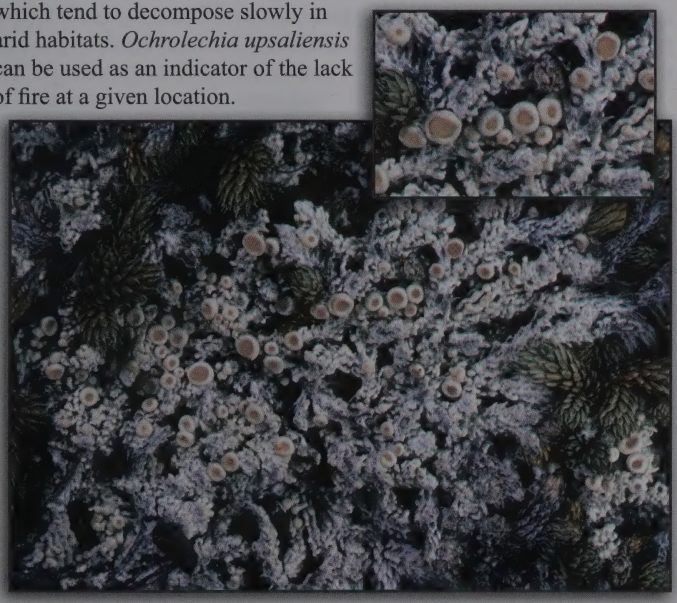
Description: Thallus thick crustose, white to cream, coarsely granular to wrinkled or covered with small, thick, wart-like growths, more or less divided into many short, irregular, cylindrical, often brittle branches (coralloid). Pruinose. Apothecia abundant, generally pink or orange, sessile, mostly 0.6-2 mm diameter. Disks concave to flat, pale yellow to buff, pruinose, more or less cracked. Margins entire, thick, lecanorine, concolorous with thallus. Spores 8 per ascus, ellipsoid, colorless, single-celled, large (30-68 × 23-37 µm). Photobiont green (*Trebouxia*).

Habitat: Often growing over *Selaginella* (spike mosses) and in arid habitats and sites with shallow soils over rock. More common in cold habitats.

Chemistry: All spot tests negative on the thallus, apothecia C+ yellow.

Comments: This lichen is widespread and common, mainly growing over bryophytes, but in some dry forest sites it will grow over organic matter and detritus and cover large areas. This species was used as a dye for wool. The common name "cudbear" is derived from this use. It grows thickly and densely over spike mosses which tend to decompose slowly in arid habitats. *Ochrolechia upsaliensis* can be used as an indicator of the lack of fire at a given location.





Peltigera rufescens

Common names: Field dog lichen, felt lichen

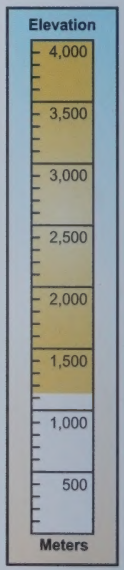
Synonyms: *Peltigera canina* var. *rufescens, P. canina*

Description: Thallus foliose, gray to grayish brown or brown, pruinose, forming approximately circular rosettes 5-15 cm diameter (occasionally much larger). Lobes narrow (usually < 1 cm wide), concave. Upper surface with abundant, thick, felt-like hairs often extending to center of thallus. Lower surface with dark veins and thick rhizines. Apothecia common, lecanorine, on raised, narrow marginal lobes which curl back toward the center of the thallus, up to 5 mm diameter. Disks orange-brown, red-brown, dark brown, or black. Spores 8 per ascus, colorless to pale brown, very narrowly cigar-shaped to needle-shaped, 2- to 6-celled, 30-70 × 3-5 µm. Photobiont blue-green (*Nostoc*).

Habitat: On mosses, mineral soils, bare ground, or organic matter.

Chemistry: All spot tests negative.

Comments: This is a nitrogen-fixing lichen. *Peltigera rufescens* is more common in more mesic habitats (i.e., higher elevations and latitudes). It commonly co-occurs with *Cladonia* species and mosses such as *Ceratodon purpureus*, *Brachythecium* species or *Syntrichia ruralis*. *Peltigera rufescens* has many more fine, felt-like hairs than *P. kristinsonii* which can have smooth, shiny portions of the upper thallus and lobe tips and a roughened appearance.



Peltula richardsii

Common name: Giant rock-olive

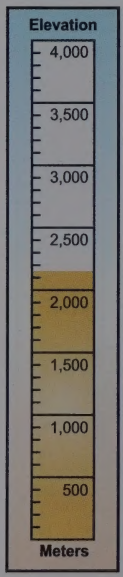
Synonym: *Heppia richardsii*

Description: Thallus squamulose, dark olive to olive-brown with rather round lobes, epruinose. Squamules attached to the substrate at the center by a clump of rhizines or a single holdfast, 2-6(10) mm diameter. Apothecia sunken into the center of the thallus and level with the surface or slightly concave. Disks red-brown (looking like a pimento in an olive), 0.5-3(5) mm diameter. Spores up to 100 per ascus, colorless, single-celled, tiny (6.5-8.5 µm diameter). Photobiont blue-green (*Anacystis*).

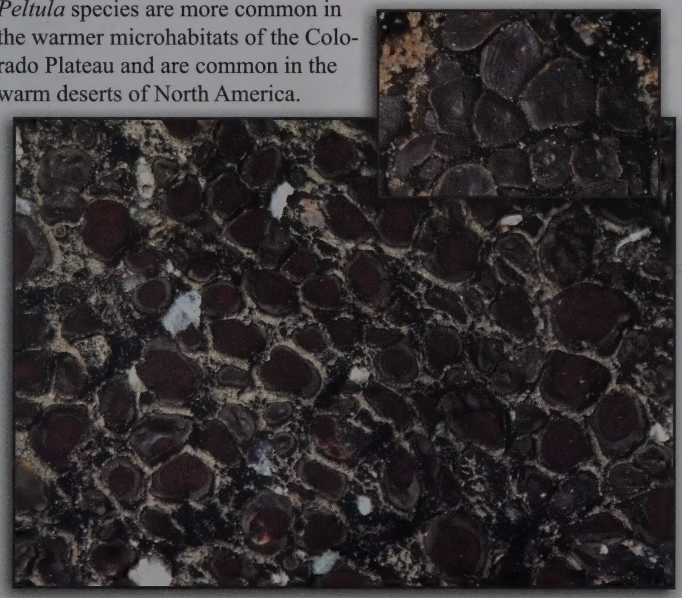
Habitat: On soils with high calcium levels, particularly in places where water runs across the surface during heavy storms.

Chemistry: All spot tests negative.

Comments: This is a nitrogen-fixing lichen. *Peltula* superficially resembles the earth or rock scale lichens (*Psora* and *Placidium,* which contain green algae) and *Heppia*. The latter also contains cyanobacteria but from a different genus (*Scytonema*), and the asci contain only 8 spores. *Peltula patellata* has a similar appearance but tends to be much smaller in overall size, and the apothecia are much smaller.



Peltula species are more common in the warmer microhabitats of the Colorado Plateau and are common in the warm deserts of North America.



Phaeorrhiza nimbosa

Common name: Brown-fuzz lichen

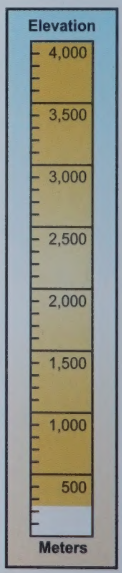
Synonyms: *Rinodina nimbosa, R. phaeocarpa*

Description: Thallus squamulose, dark brown to yellow-brown and frequently pruinose, appearing gray to whitish when dry and darkening when wet. Squamules almost continuous with lobed margins, sometimes overlapping, generally greater than 1 mm broad. Marginal lobes 0.2-0.5 mm broad. Lower surface with rhizine-like hyphae. Apothecia extremely abundant and crowded, immersed when young, becoming lecanorine, with flat, dark brown to black disks and thick margins when mature, 0.4-1.5(2.5) mm diameter—the apothecia are distinctive. Spores 8 per ascus, brown, 2-celled, with more or less uniformly thin walls, 17-24 × 7-12 µm. Photobiont green (*Trebouxia*).

Habitat: On dry, calcareous soils.

Chemistry: All spot tests negative.

Comments: The only other common species of *Phaeorrhiza* in North America is *P. sareptana*, a lichen found mainly in the mountains, prairies, and steppes of the dry interior. Its thallus is distinctly squamulose with black, convex, marginless, lecideine apothecia and K+ violet reaction on the lower surface. *Phaeorrhiza nimbosa* is more common in old growth sites and in alpine areas (Brodo et al. 2001).



Physconia muscigena

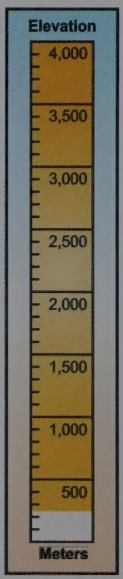
Common name: Ground frost lichen

Synonym: *Physcia muscigena*

Description: Thallus narrow foliose, from pale green or gray-brown to dark brown, irregular or (rarely) circular in outline, 5 cm or more diameter. Lightly to heavily coated with pruina that resemble hoarfrost. Pruina disappear when moist, and the thallus turns a brighter green. Lobes curving up at the edges, elongate or short, dissected, distinctly overlapping like shingles and somewhat hollowed, flattened, up to 4 mm wide. The underside is black with scattered black bottle-brush-like rhizines which are obvious and abundant. Loosely attached to substrate. Apothecia common with a smooth margin becoming lecanorine, up to 5 mm diameter. Disks dark brown and usually whitened with pruina. Spores 8 per ascus, brown, single-celled, usually with thin, more or less uniform walls except for a thickened cell wall in young spores, 24-33 × 12-17 µm. Photobiont green (*Trebouxia*).

Habitat: A common species of open grasslands on lime-rich soils, moss mats, and at the base of shrubby vegetation. Common in the Great Plains and Columbia Basin and in alpine areas.

Chemistry: All spot tests negative.



Comments: This species is as easily damaged as many fruticose lichens when dry. Many habitats have lost this species due to livestock grazing and trampling.

Physconia perisidiosa

Common name: Crescent frost lichen

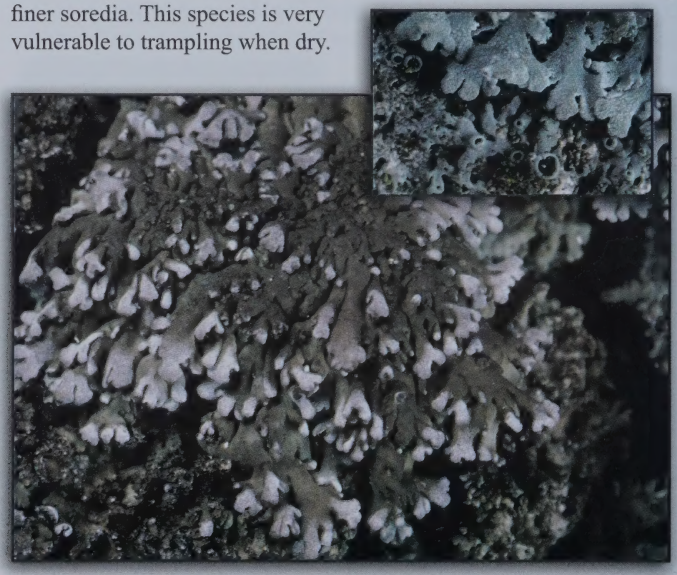
Synonyms: *Physconia farrea, P. grisea, Parmelia farrea*

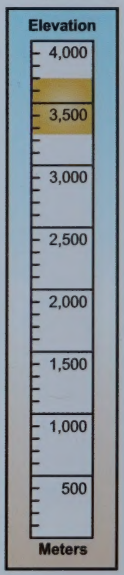
Description: Thallus foliose, gray to dark brown, usually with a mauve or purplish tinge, irregular in outline, more or less loosely attached. Lobes short, more or less imbricate, often pruinose (especially at tips), non-pruinose parts more or less glossy, 0.5-1.2 mm wide. Soralia lip-shaped. Marginal lobes often confluent and densely isidiate in center of thallus. Medulla white. Underside whitish and lacking the cortex at tips, becoming blackish and corticate within, with black, bottle-brush-like rhizines. Apothecia very rare, lecanorine. Disks brown or white pruinose, often with lobules or soredia on the margins. Exciple lecanorine, often with sorediate lobules. Spores 2-celled, brown, generally greater than 24 × 13 µm. Photobiont green (*Trebouxia*).

Habitat: On bark, less frequently on soils or rock, in sites protected from trampling.

Chemistry: All spot tests negative.

Comments: The discrete soralia, usually on the lobe tips, distinguishes this species from the more common bark-dwelling *Physconia detersa, P. enteroxantha,* and *P. isidiigera*, in which the soredia are strictly marginal or rarely occur on lobe tips. In *P. leucoleiptes,* one finds somewhat crescent-shaped soralia containing finer soredia. This species is very vulnerable to trampling when dry.





Placidium lacinulatum

Common name: Brown stipplescale

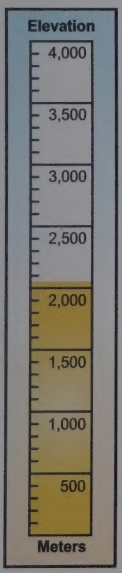
Synonyms: *Catapyrenium lacinulatum, Dermatocarpon hepaticum*

Description: Thallus squamulose, brown, 3-6 mm wide, separate to imbricate, round to lobate, epruinose. Lobe margins adnate to slightly upturned. Undersurface pale, anchored tightly to the soil by a bundle of usually pale rhizines. Perithecia frequent and visible as occasional black dots which are upraised pores on the thallus surface. Spores 8 per ascus, single-celled, colorless, elliptical, 15-19 × 7.5-9.5 µm. Photobiont green, chlorococcoid (*Pleurococcus or Myrmecia*).

Habitat: Often on shallow, silty soils in arid and non-arid habitats.

Chemistry: All spot tests negative.

Comments: *Placidium* is among the most abundant lichen genera of the North American deserts and occupies a variety of habitats. The *P. squamulosum-lacinulatum-lachneum* group is very difficult to distinguish in the field; they require examination under a microscope for a firm identification. *Placidium squamulosum* lacks rhizines and is anchored by numerous, small-diameter, rhizoidal hyphae, while *P. lacinulatum* is anchored by thick rhizines. The underside of *P. lachneum* is dark, while that of *P. lacinulatum* is light-colored. This lichen is often found with *Collema tenax* growing between the individual squamules.



Placidium squamulosum

Common names: Stipplescale lichen, earthscale

Synonyms: *Catapyrenium squamulosum*, *Dermatocarpon hepaticum*

Description: Thallus squamulose, brown when dry and green when wet. Nearly completely attached to the substrate or the margins slightly upturned. Epruinose. Squamules separate to imbricate, more or less round to slightly lobate, size variable (2-7 mm). Undersurface pale, entire undersurface attached by rhizoidal hyphae. Perithecia frequent and visible as upraised black pores on the thallus. Spores 8 per ascus, single-celled, ellipsoid, 12-16 × 5.5-7.5 µm. Photobiont green, chlorococcoid (*Pleurococcus* or *Myrmecia*).

Habitat: Common on soils in arid and other regions of North America.

Chemistry: All spot tests negative.

Comments: See the comments for *Placidium lacinulatum*. *Placidium squamulosum* is very common in the Colorado Plateau region but is less common in northern arid regions. This species appears to be an early colonizer of disturbed sites.

Placynthiella spp.

This includes: *Placynthiella icmalea, P. uliginosa, P. oligotropha,* and *Placynthium nigrum*

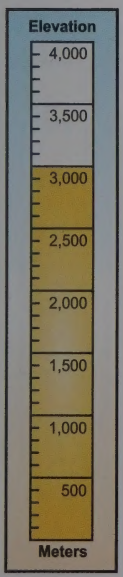
Synonyms: *Lecidea, Saccomorpha*

Description: Thallus crustose, brown to almost black, often tinged yellowish green when wet, coarsely granular, covered with small wart-like growths. Granules 100-300 µm diameter, more or less contiguous or dispersed. Surface rugose-roughened, dull. Soredia absent. Epruinose. Apothecia rare, black with a black rim, at first flat with a more or less elevated true exciple, occasionally becoming convex and lacking a well-defined edge, 0.2-0.5 mm diameter. Spores 8 per ascus, single-celled, colorless, ellipsoid, thin-walled, often containing a few large oil drops, 10-15 × 4-7 µm. Photobiont green (*Chlorella*).

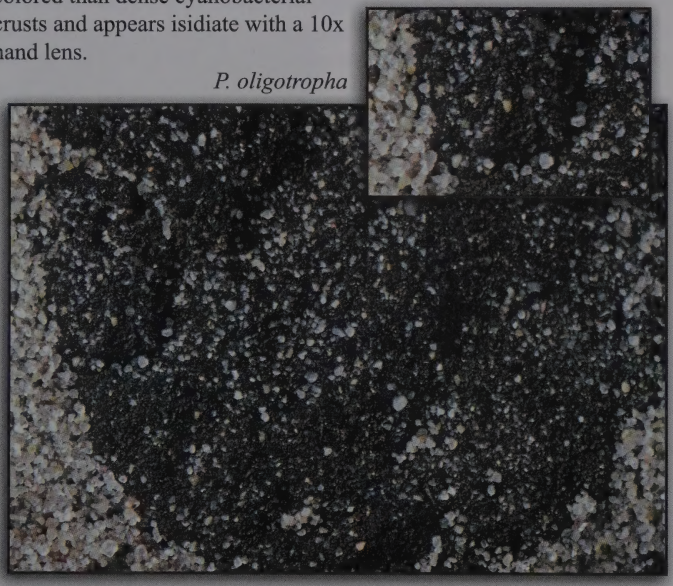
Habitat: On bare peaty or sandy soils, well-rotted lignum, or organic matter, usually in the open or in partial shade in cold deserts and more moist habitats.

Chemistry: All spot tests negative.

Comments: *Placynthiella* species are common over organic matter and are easily overlooked due to their thin covering over the substrate and their drab brown color which is often similar to the color of the substrate. *Placynthiella* is more brown-colored than dense cyanobacterial crusts and appears isidiate with a 10x hand lens.



P. oligotropha



Psora cerebriformis

Common names: Brain scale, cerebral fishscale, fissured scale lichen

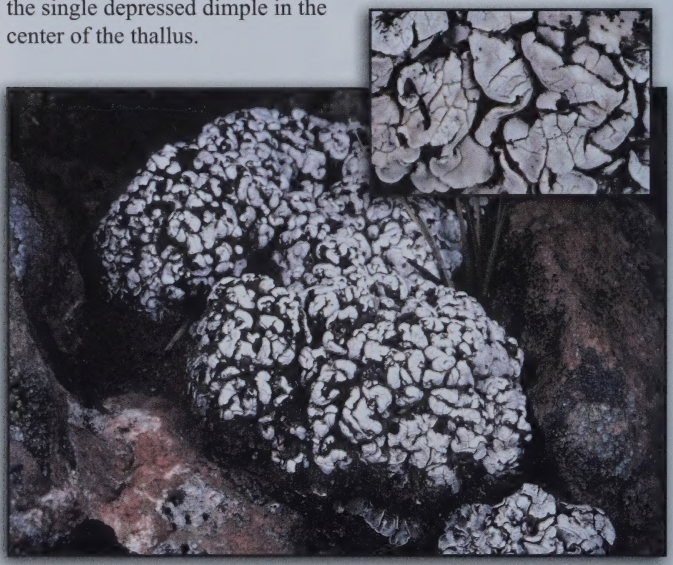
Synonym: *Lecidea cerebriformis*

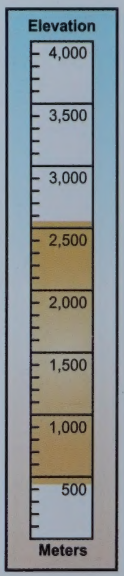
Description: Thallus squamulose, usually white due to dense pruina, otherwise pale brown to olive-brown. Entire colonies of squamules in a hemispherical shape resembling a brain. Pruinose. Squamules are usually very convex, fissured or cracked on the surface, folded and imbricate, but occasionally flat, mostly 2-6 mm across. Rhizines lacking. Apothecia common and black or sometimes green, hemispherical, borne on squamule margins, up to 2 mm diameter. Spores 8 per ascus, single-celled, colorless, ellipsoid, 7-18 × 5-9 µm. Photobiont green (*Myrmecia*).

Habitat: On calcareous soils, particularly at middle elevations.

Chemistry: C-, K+ yellow or red, KC-, P-.

Comments: *Psora cerebriformis* is particularly common on calcareous soils in cool deserts and at higher elevations in warm deserts. It is a common associate of *P. decipiens*, *Toninia sedifolia*, *Fulgensia* species, *Collema tenax,* and *C. coccophorum*. Highly pruinose specimens of *P. crenata* may resemble this species but tend to have smaller apothecia and larger squamules which are smooth except for the single depressed dimple in the center of the thallus.





Psora crenata

Common names: Brick scale, crenate fishscale lichen

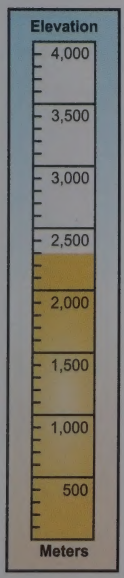
Synonyms: *Lecidea coroniformis, L. crenata*

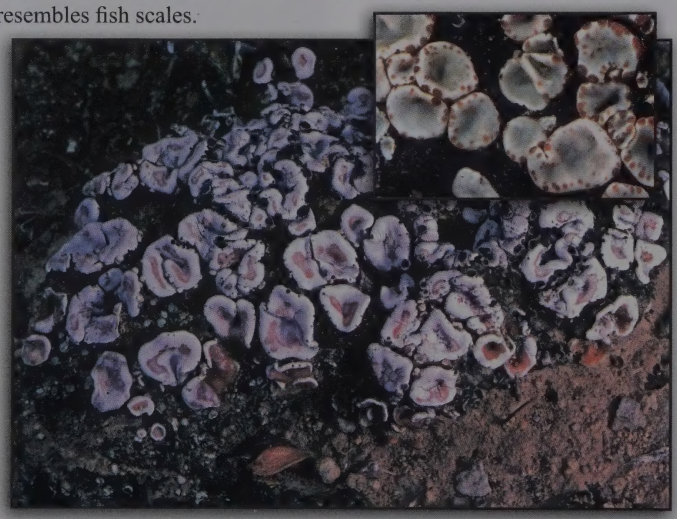
Description: Thallus squamulose, pink to brownish red or often whitish due to dense pruina, the entire colony of squamules 1-10 cm diameter. Squamules middle-sized to large (~ 1 cm), round to irregular, rarely flat, more commonly conspicuously concave. Margin down-turned, somewhat imbricate or crowded. Rhizines lacking. Apothecia common and black, flat to somewhat convex, small (up to 2 mm), borne on squamule margins. Spores 8 per ascus, single-celled, colorless, ellipsoid, 7-18 × 5-9 µm. Photobiont green (*Myrmecia*).

Habitat: On soils in arid mid-elevation sites, particularly in the Sonoran and Chihuahuan deserts. Often on calcareous soils.

Chemistry: C-, K+ red, KC-, P+ yellow.

Comments: *Psora crenata* is an especially common component of biological soil crusts in the ecotone between the Colorado Plateau and Sonoran Deserts. It often co-occurs with *P. icterica*. Less concave specimens of *P. crenata* could be confused with *P. cerebriformis* which has flat to convex squamules and a hemispherical brain-like morphology. *Psora decipiens* is generally pink to red (not entirely covered in pruina) and has smaller, flat squamules and larger apothecia. The common name comes from the shape of the thallus which resembles fish scales.





Psora decipiens

Common names: Blushing scale, sockeye scale, white-edged red scale, pink polka dot lichen

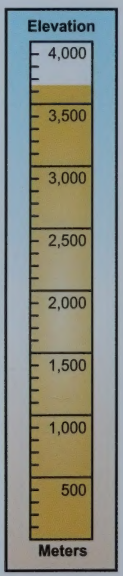
Synonym: *Lecidea decipiens*

Description: Thallus squamulose, pinkish orange to brick red, the entire colony of squamules about 0.5-2 cm diameter, crowded or separate. Squamules more or less round to lobate, usually less than 5 mm diameter, pruinose. Margins distinctly white. Rhizines lacking. Apothecia marginal, black and convex, common, 0.7-2 mm diameter. Spores 8 per ascus, single-celled, colorless, ellipsoid, 7-18 × 5-9 µm. Photobiont green (*Myrmecia*).

Habitat: On calcareous soils, especially gypsiferous soils.

Chemistry: All spot tests negative.

Comments: *Psora decipiens* is abundant on calcareous soils, occurring alongside such species as *Placidium lachneum, Toninia sedifolia, Collema tenax, C. coccophorum,* and *Fulgensia desertorum*. *Psora tuckermanii* is similar in size and growth form but has apothecia that are laminal and reddish brown rather than black. If the squamules are very dimple-shaped with a depression in the middle then it may be *Psora crenata*, and if the group of squamules are clustered and rounded in a brain-like shape it may be *P. cerebriformis*. All three of these species are occasionally white-looking from a heavy calcareous covering of pruinose crystals.



Psora icterica

Common names: Yellow scale, fishscale lichen

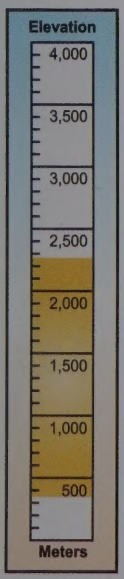
Synonym: *Lecidea icterica*

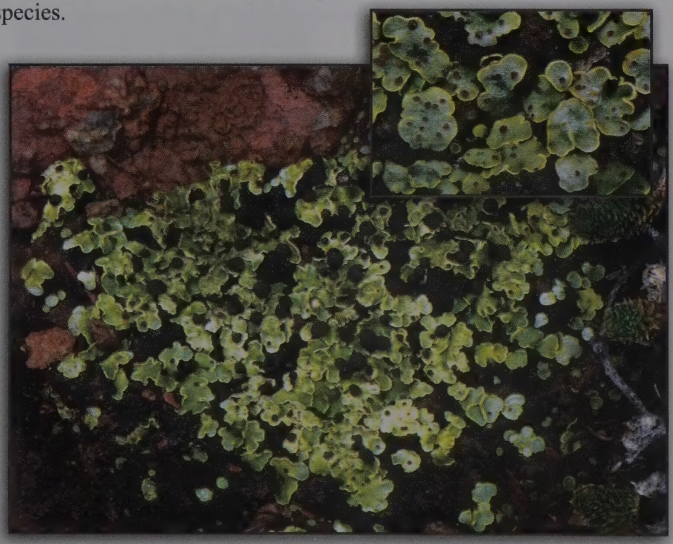
Description: Thallus squamulose, bright yellow to green-yellow to sulfur green, greener when moist. Upper surface dull, fissures present or lacking, with or without pruina. Pruina can give the thallus a white color or cast when dry. Squamules attached to the substrate with lobate margins somewhat upturned, scattered to contiguous. Rhizines lacking. Apothecia common, hemispherical, dark brown to black, epruinose, variable in size. The upturned margins can appear slightly lighter in color. Spores 8 per ascus, single-celled, colorless, ellipsoid, 7-18 × 5-9 µm. Photobiont green (*Myrmecia*).

Habitat: On soils in arid regions.

Chemistry: C-, K-, KC-, P-, UV+ dull orange (rhizocarpic acid).

Comments: *Psora icterica*'s yellowish green to sulfur green color distinguishes it from almost all other lichens in these warm desert regions. The squamules can be dense or sparse and are more spread out than many other *Psora* species. It could be confused with *Acarospora schleicheri,* but it has small hemispherical apothecia in contrast with the larger, flat, immersed apothecia of *A. schleicheri,* which also has a more sulfur yellow-green thallus. *Acarospora schleicheri* has a more northerly distribution than *P. icterica* and co-occurs with *Cladonia* species.





Psora montana

Common name: Little brown-eyed scale

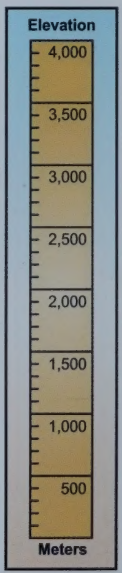
Synonym: None

Description: Thallus small, squamulose, medium brown to dark reddish brown, dull to somewhat shiny, epruinose or more rarely somewhat pruinose. Squamules 0.5-2 mm diameter, elongated, attached to the substrate or partly curving up, contiguous or irregularly imbricate. Margins the same color as the upper surface or somewhat paler, usually straight, deeply incised to lobate. Lower surface pale brown to medium brown. Rhizines lacking. Apothecia laminal, usually weakly to moderately convex, up to 1.2 mm diameter. Apothecia can be nearly half the size of the squamules and are mounded upon the squamule, protruding. Spores 8 per ascus, single-celled, colorless, 9-14 × 5-7 µm. Photobiont green (*Myrmecia*).

Habitat: On soils or in rock crevices, as well as in rock crevices in alpine areas, common in the Great Basin and Columbia Basin.

Chemistry: Medulla C+ reddish or C-, KC+ reddish or KC- (gyrophoric acid); squamules C+ red or KC+ red. However, this reaction is unreliable and TLC is needed to confidently distinguish between *P. montana* and *P. globifera*.

Comments: *Psora montana* has squamules smaller than many other *Psora* species. *Psora montana* is similar to *P. pacifica* but with closely attached squamules and almost black apothecia.



Psora tuckermanii

Common name: Brown-eyed scale

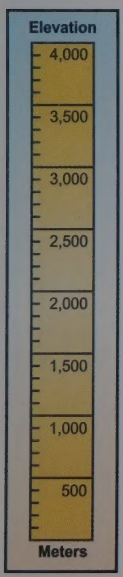
Synonym: None

Description: Thallus squamulose, pale yellowish brown to almost chocolate brown with frosty, white, pruinose margins. Squamules smooth and somewhat shiny, scale-like, mostly crowded, overlapping, medium-sized. The entire colony can be 10-25 cm. Rhizines lacking. Apothecia laminal or marginal, round, mostly reddish brown, and up to 2.5 mm wide. Spores 8 per ascus, single-celled, colorless, ovoid-ellipsoid, 9-14 × 5-6.5 µm. Photobiont green (*Myrmecia*).

Habitat: On soils and soil over rock, common in cold deserts.

Chemistry: All spot tests negative.

Comments: Slicing into the apothecia to observe the color will help distinguish this from *Psora decipiens* which has black apothecia. *Psora tuckermannii* has pruinose margins that distinguishes it from *P. globifera*. *Psora tuckermannii* is similar to *P. pacifica* but with more closely attached squamules and almost black apothecia. *Psora tuckermanii* is endemic to North America and is named after Tuckerman, who was an early North American lichenologist based at Harvard University.



Squamarina lentigera

Common names: White rim lichen, rim lichen

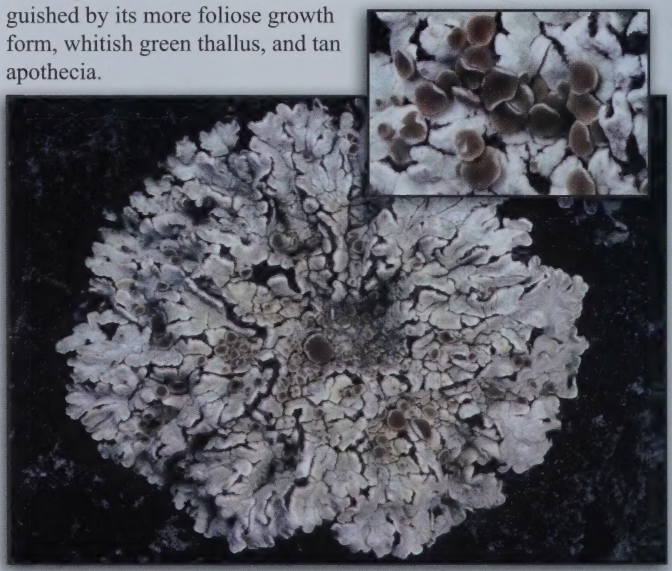
Synonym: *Lecanora lentigera*

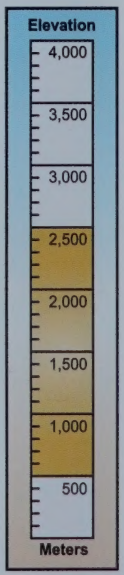
Description: Thallus squamulose with slightly foliose lobe margins, generally appearing whitish green due to white pruina over a yellowish green cortex. Squamules form distinct rosettes attached to the substrate, about 3-6 cm diameter (occasionally much larger). Thallus margin distinctly lobate. Lower surface pale, rarely darkening, with rather few and inconspicuous rhizines. Apothecia are common, lecanorine, rimmed and tan-colored, up to 4 mm diameter. Spores 8 per ascus, single-celled, colorless, ellipsoid, thin-walled, 12-14 × 4-5 µm. Photobiont green, chlorococcoid, unicellular.

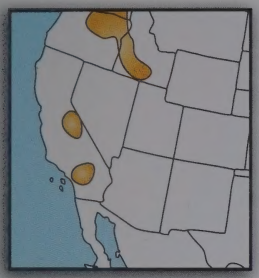
Habitat: On calcareous and especially gypsiferous soils in arid regions.

Chemistry: C-, K+ pale yellow or red, KC+ yellow, P-.

Comments: Common, but generally not abundant on gypsum-containing soils, especially in the Colorado Plateau region where it can be very foliose and is easily separated from substrate. May occasionally form impressively large populations covering up to a square meter. It is found along with *Psora decipiens*, *Fulgensia bracteata*, *Diploschistes diacapsis,* and an unusually diverse gypsum soil crust flora. Although it occurs with several other whitish lichens, it is easily distinguished by its more foliose growth form, whitish green thallus, and tan apothecia.







Texosporium sancti-jacobi

Common name: Woven-spore lichen

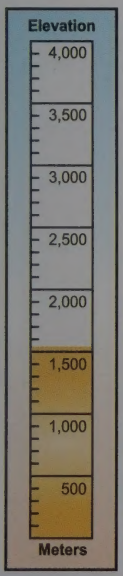
Synonym: *Cyphelium sancti-jacobi*

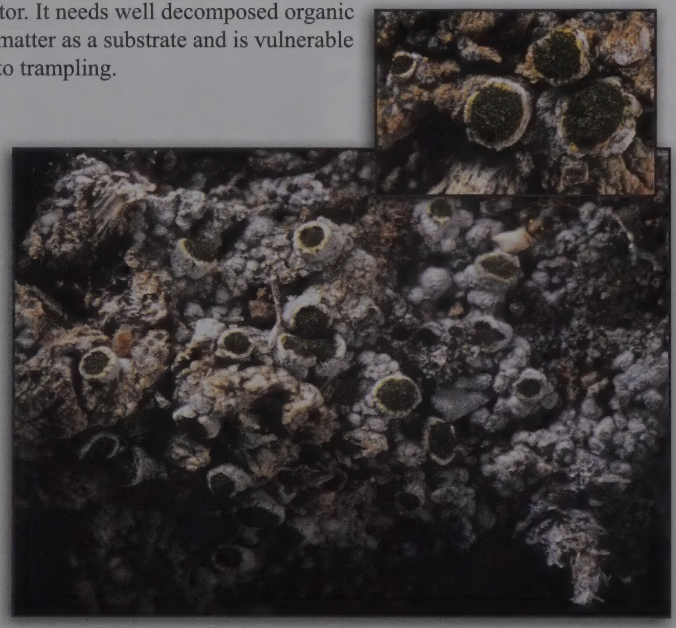
Description: Thallus crustose, thin, whitish to pale grayish, pruinose. Patches of thalli with clusters of apothecia range in size from 0.3 to 3 cm diameter. Apothecia are circular, 0.5-1.5 mm diameter, with a lecanorine margin concolorous with the thallus. The centers of the apothecia are filled with a characteristic dark, powdery, spore mass ranging from blackish to olive green in color and often tinged with bright yellow at the rim. Spores 8 per ascus, 2-celled (which will be apparent only in the immature spores found at the base of the apothecium), black, 19-26 × 10-14 µm. As the spores mature, they become tightly wrapped with fungal hyphae that become progressively darker and thicker, thus obscuring the spore structure. Photobiont green, chlorococcoid.

Habitat: Rare and inconspicuous, on organic matter and organic soils.

Chemistry: All spot tests negative.

Comments: The coloration of the yellow rim, in contrast to the olive-green to black apothecia, is diagnostic. This lichen is uncommon and is an old growth sagebrush habitat indicator. It needs well decomposed organic matter as a substrate and is vulnerable to trampling.





Thrombium epigaeum

Common name: Thrombium lichen

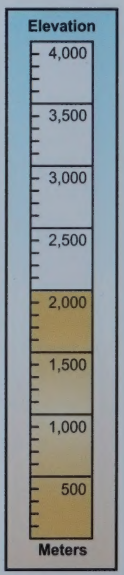
Synonym: None

Description: Thallus crustose, often finely granulose, grayish, greenish, or yellowish green to brownish, effuse, film-like, smooth, slightly uneven or disappearing at maturity. Upper surface subgelatinous when wet. Epruinose. Perithecia almost globose, fully immersed with only the ostioles showing as black dots, up to 0.45 mm diameter. Exciple brown, 250-400 µm diameter. Spores 8 per ascus, single-celled, colorless, 15-30 × 5-12 µm. Photobiont green, chlorococcoid (*Leptosira*).

Habitat: An ephemeral early colonizer of more or less calciferous, clayey soils, often in rather disturbed habitats.

Chemistry: All spot tests negative.

Comments: This species is easily overlooked and under-collected. It can be common on mineral soils low in organic matter and is difficult to collect. It is very fragile and, if not properly processed, will break apart and become piles of unidentifiable soil. This early ephemeral colonizer can stabilize soil for further colonization by other species. It is widespread and most easily recognized when moist. The surface of this lichen can be green or white when dry. One has to look closely to see the black perithecia.



Toninia ruginosa

Common name: Black and bruised lichen

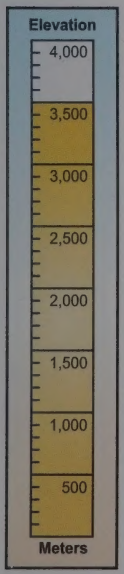
Synonym: *Toninia caeruleonigricans*

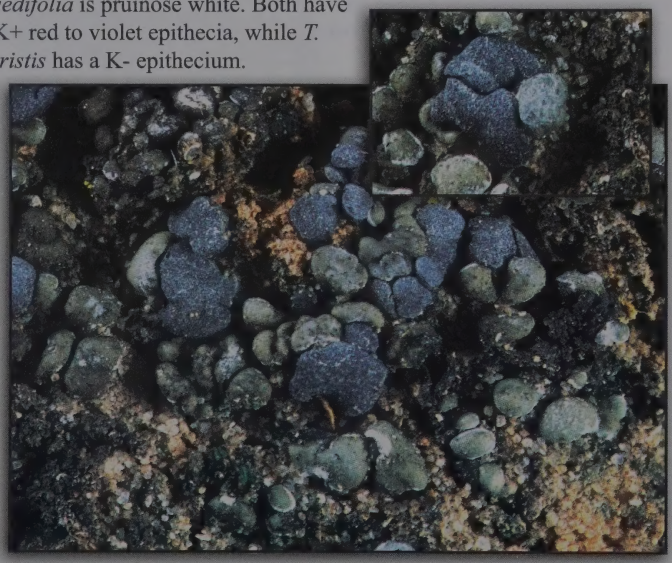
Description: Thallus squamulose, greenish to yellowish brown or bluish to almost black. Squamules round, swollen, more or less crowded, wavy, rough, folded, up to 5 mm diameter. Rhizines lacking. Apothecia 0.2-3 mm across. Disks dull black to jet black, flat to slightly convex. Exciple thick, black, becoming curved, finally disappearing. Spores 1- to 8-celled, needle-shaped, about 2-3 × 16-23 µm. Photobiont green, chlorococcoid.

Habitat: On soils and rock in open habitats and woodlands, often on calcareous soils.

Chemistry: All spot tests negative on the thallus.

Comments: Most *Toninia* species become established on other lichen thalli as weak parasites before becoming free-living, and some remain as parasites. The preferred hosts are generally cyanobacterial lichens such as *Collema* and *Placynthium*, but some common *Toninia* species such as *T. ruginosa*, grow on green algal lichens. They are often in lichen communities that include calcareous soils and rock lichens such as *Endocarpon, Fulgensia, Placidium,* and *Peltula*. Other species of *Toninia* can be found on soils and soil on rock ledges. Unlike *T. ruginosa*, *T. sedifolia* is pruinose white. Both have K+ red to violet epithecia, while *T. tristis* has a K- epithecium.





Toninia sedifolia

Common names: Earth-wrinkles, blue blister lichen

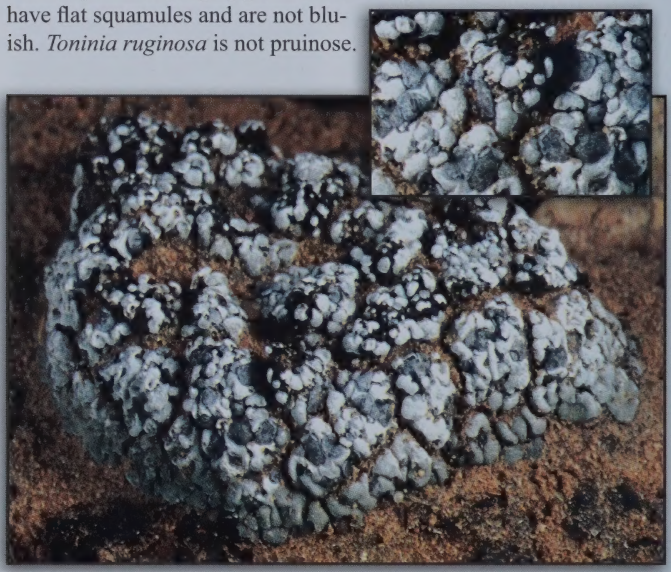
Synonym: *Toninia caeruleonigricans*

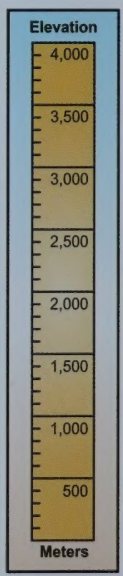
Description: Thallus squamulose, upper surface bluish gray or grayish olive due to dense pruina. Squamules convex, ranging from round to irregular and folded, up to 3 mm diameter. Lower surface dark olive-green to dark grayish green underneath. Rhizines lacking. Apothecia lecideine, black and convex, borne between the squamules. Spores 8 per ascus, 2-celled, colorless, ellipsoid to needle-shaped. Photobiont green, chlorococcoid, unicellular.

Habitat: On calcareous soils and on limestone rocks and in limestone rock crevices.

Chemistry: All spot tests negative.

Comments: This species is common in the Colorado Plateau region and middle to upper elevations of the warm deserts; it is less common in the Great Basin, Great Plains, and Columbia Basin. It is commonly found with other lime-loving species such as *Psora decipiens*, *P. cerebriformis*, *Collema coccophorum*, and *Placidium lachneum*. Its convex squamules, bluish gray color, and hemispherical black apothecia make it fairly easy to identify. It could potentially be confused with some small-squamuled, highly pruinose *Psora* species, but most of these have flat squamules and are not bluish. *Toninia ruginosa* is not pruinose.





Trapeliopsis glaucopholis

Common name: Coastal trapeliopsis

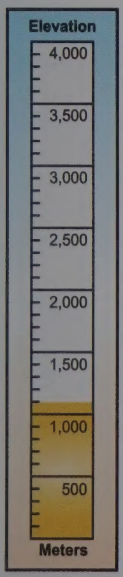
Synonyms: *Trapeliopsis wallrothii, T. californica*

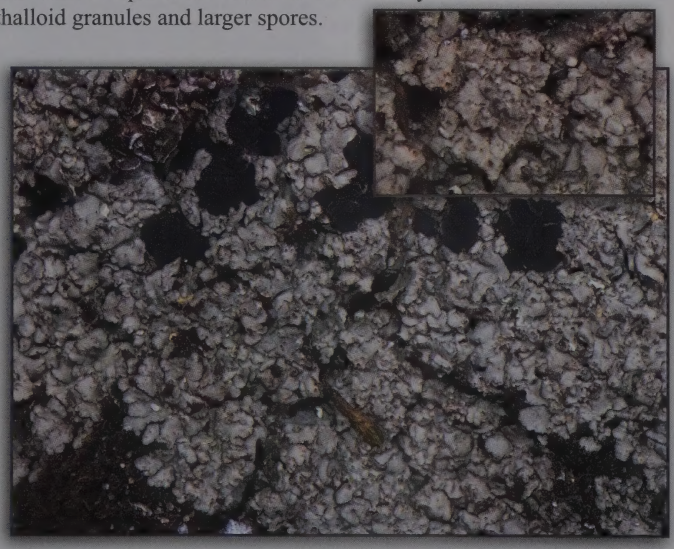
Description: Thallus thick squamulose, white, cream, pale gray to medium gray, slightly to distinctly glossy, forming colonies up to 10 cm or more diameter, epruinose. Squamules usually convex, contiguous to imbricate, edges of squamules appressed or free, 1-4 mm diameter, edge often weakly dissected into lobes about 1 mm wide. Lower surface tan to white, corticate where free. Rhizines lacking. Apothecia common, dull black, gray-black, grayish, pinkish brown or variegated with those colors, up to 2(6) mm diameter, often dividing into compound apothecia. Margin lecideine. Spores 8 per ascus, single-celled, 5.5-8.0 × 3-4 µm. Photobiont green, chlorococcoid.

Habitat: Usually on soils and mosses over rock in relatively dry habitats.

Chemistry: Thallus C+ red, K-, KC+ red, P-, UV-.

Comments: *Trapeliopsis steppica* is distinguished from *T. glaucopholis* by the presence of dark granular soredia in discrete roundish soralia, a thinner duller cortex, and slightly smaller and more appressed squamules. The upper cortex of *T. glaucopholis* averages about twice as thick as the cortex in *T. steppica*. *Trapeliopsis wallrothii* is a European species and the name has been misapplied in North America. It has flatter squamules which are often nearly areolate with coarse thalloid granules and larger spores.





Trapeliopsis granulosa

Common name: Mottled-disk trapeliopsis

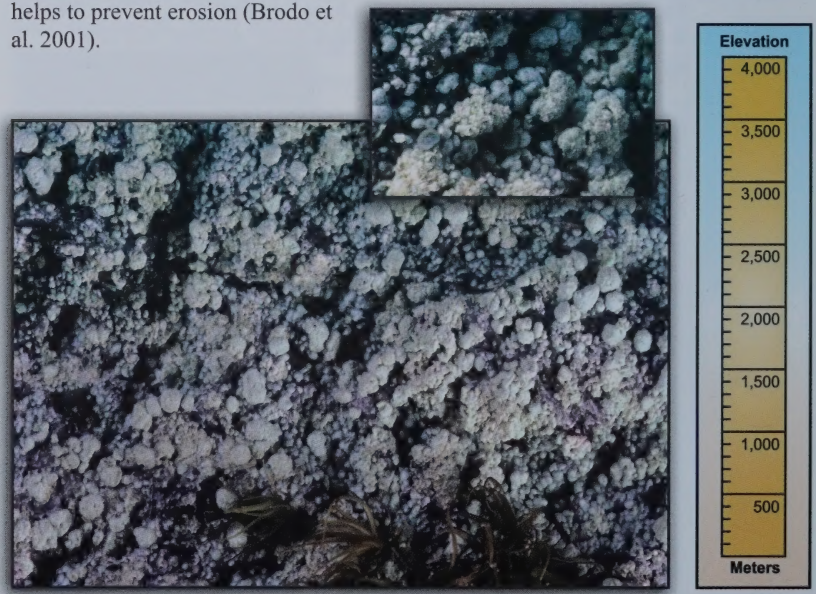
Synonyms: *Lecidea grandulosa, L. quadricolor*

Description: Thallus pale green, gray, white to sometimes brownish, thin to granular and breaking into patchy soredia, or at least with a rough and wart-like texture. Soredia whitish to yellow-brown in color. Apothecia round to wavy with a constricted base, pale pinkish brown to dark brown. Spores 9-13 × 4-6 µm. Photobiont green (*Trebouxia*).

Habitat: On organic matter and dead plant parts. Widespread and common, occurring in all habitat types, but more frequent in cooler and montane areas. This species is very widespread and can cover large areas among the trees in dry woodlands (pinyon and ponderosa pine), and prefers acidic soils or organic matter but can also be found on bare soils and charred wood.

Chemistry: C+ pink, K-, KC+ red, P-.

Comments: Because this species is an important early colonizer of bare soils, organic mulch, or decomposed wood, forest managers in Quebec have disseminated this lichen over tracts of recently burned forest. The whitish thallus reflects sunlight, cooling the surface and allowing it to accumulate more moisture. The lichen itself helps to prevent erosion (Brodo et al. 2001).



Trapeliopsis steppica

Common name: Inland trapeliopsis

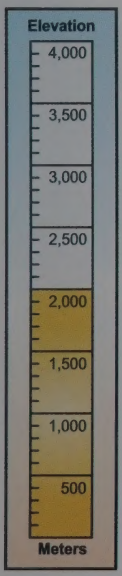
Synonym: *Trapeliopsis wallrothii*

Description: Thallus squamulose, cream to light gray or more often medium gray, dull, occasionally appearing somewhat pruinose. Squamules contiguous to imbricate, roundish to elongate, 0.15-0.50 mm thick and 0.5-1.5 mm long, appressed, marginally downrolled or ascending. Soredia usually present, dark gray to black or greenish black, in discrete, roundish soralia that are slightly concave to convex. Rhizines lacking. Apothecia rare, sessile, pinkish brown to almost black. Spores 8 per ascus, single-celled, colorless, ellipsoid, 18-28 × 8-18 µm. Photobiont green, chlorococcoid (possibly *Chlorella* or *Pseudochlorella*).

Habitat: On soils, soil over rock, or moss over rock in grassland and shrub steppes, generally in areas little disturbed by grazing.

Chemistry: Thallus C+ red, K-, KC+ red, P-, UV-.

Comments: *Trapeliopsis steppica* is differentiated from *T. glaucopholis* by the presence of dark granular soredia in discrete roundish soralia, a thinner duller cortex, and slightly smaller and more appressed squamules. *Trapeliopsis steppica* differs from *T. bisorediata* in having only dark soralia which tend to be marginal rather than central in the areolae. *Trapeliopsis steppica* is also somewhat darker gray in color, less pruinose, and more squamulose. This lichen is a good indicator of old growth arid habitats.



Xanthoparmelia chlorochroa

Common name: Tumbleweed shield lichen

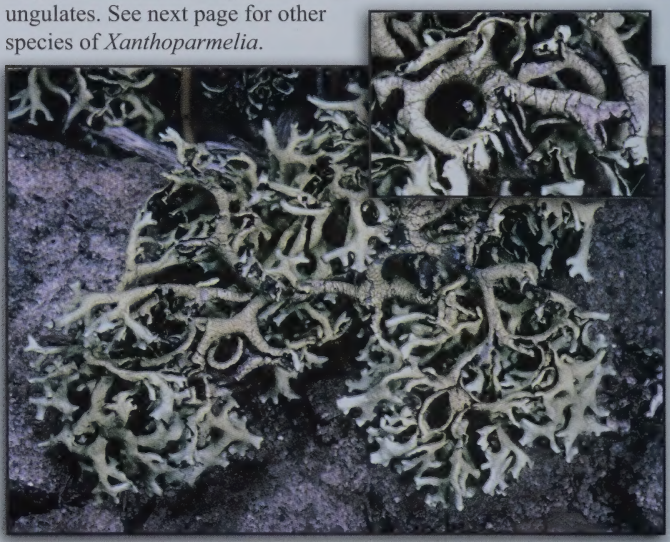
Synonyms: *Parmelia chlorochroa, P. molliuscula*

Description: Thallus foliose and vagrant, yellowish green, forming rounded cushions of dichotomously branched lobes, epruinose. Lobes somewhat flattened (dorsiventral) to in-rolled, generally 1-5 mm wide, with margins strongly curled inward, almost forming tubes. Lower surface pale to dark brown, strongly convex but not completely in-rolled, often with raised rim toward apices, moderately to densely rhizinate, closely or loosely appressed or unattached. Rhizines concolorous with lower surface. Apothecia rare, lecanorine, with broad brown disks and thallus-colored margins. Spores 8 per ascus, single-celled, colorless, ellipsoid, 6-13 × 4-8 µm. Photobiont green (*Trebouxia*).

Habitat: On mineral soils and rock. Most species are found in open, relatively dry sites. Vagrant on desert and steppe soils.

Chemistry: Medulla C-, K+ red, KC-, P+ orange.

Comments: Some lobate species of *Lecanora*, such as *L. muralis* and *L. novomexicana*, can also resemble *Xanthoparmelia*. *Xanthoparmelia neochlorochroa* has a different chemistry and a black lower surface, and *X. norchlorochroa* has a dull black lower surface lacking rhizines and with pronounced reticulate ridges and veins. This species is a common food for wild and domestic ungulates. See next page for other species of *Xanthoparmelia*.



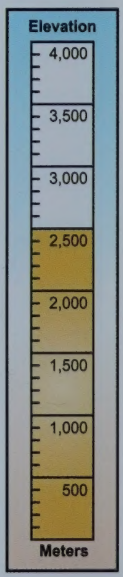


Table of the common soil-occurring *Xanthoparmelia* species.

Species	Morphology	Chemistry	Habitat
camtschadalis (ND)	Upper surface with small light-colored spots (maculate), rhizines	Cortex K-, KC+ yellow, medulla K+ yellow becoming reddish orange or orangish red, P+ yellowish or orangish (salazinic acid)	Shrub steppe/ badlands
chlorochroa	Broad lobes, rhizines	Medulla K+ red, KC-, C- (salazinic acid), and P+ orange	Grasslands
neochlorochroa (ND)	Rhizines, broad lobes	Medulla K+ yellow to red (norstictic acid)	Calcareous rangelands
norchlorochroa (ND)	No rhizines	Medulla C-, K+ red, KC- (norstictic acid) and P+ orange	Calcareous badlands
wyomingica (ND)	Narrow lobes, rhizines	Cortex KC+ yellow, medulla K+ yellow turning red, P+ orangish (salazinic acid)	Rocky windswept sites

X. camtschadalis

X. wyomingica

X. norchlorochroa

X. neochlorochroa

Appendix: Authorities

Species	Authority
Acarospora nodulosa var. *nodulosa*	(Dufour) Hue.
Acarospora schleicheri	(Ach.) A. Massal.
Aspicilia aspera	(Mereschk.) Tomin
Aspicilia desertorum form *terrestris*	Tomin (Tomin)
Aspicilia filiformis	Rosentr.
Aspicilia fruticulosa	(Eversm.) Flagey
Aspicilia hispida	Mereschk.
Aspicilia mastrucata	(Wahlenb.) Th. Fr.
Aspicilia reptans	(Looman) Wetmore
Athalmia hyalina	(Somm.) Hatt.
Bryum argenteum	Hedw.
Bryum caespiticium	Hedw.
Buellia elegans	Poelt
Buellia punctata	(Hoffm.) A. Massal.
Caloplaca tominii	Savicz
Candelariella citrina	de Lesd.
Cephaloziella divaricata	(J. E. Smith) Schiffner or (Sm.) Schiffn
Ceratodon purpureus	(Hedw.) Brid.
Cladonia fimbriata	(L.) Fr.
Cladonia pocillum	(Ach.) Grognot
Collema coccophorum	Tuck.
Collema tenax	(Sw.) Ach.
Didymodon vinealis	(Brid.) Zand.
Diploschistes diacapsis	(Ach.) Lumbsch.
Diploschistes muscorum	(Scop.) R. Sant.
Encalypta vulgaris	Hedw.
Endocarpon pusillum	Hedw.
Fossombronia longiseta	(Austin) Austin
Fulgensia bracteata	(Hoffm.) Räsänen
Funaria hygrometrica	Hedw.
Heppia lutosa	(Ach.) Nyl.
Leptochidium albociliatum	(Desmaz.) M. Choisy

Species	Authority
Leptogium lichenoides	(L.) Zahlbr.
Massalongia carnosa	(Dickson) Korber
Megaspora verrucosa	(Ach.) Hafellner & V.Wirth
Ochrolechia upsaliensis	(L.) A. Massal.
Peltigera rufescens	(Weis.) Mudd
Peltula richardsii	(Herre) Wetmore.
Phaeorrhiza nimbosa	(Fr.) H. Mayrh. & Poelt
Physconia muscigena	(Ach.) Poelt
Physconia perisidiosa	(Erichsen) Moberg
Placidium lacinulatum	(Ach.) Breuss
Placidium squamulosum	(Ach.) Breuss
Psora cerebriformis	Weber
Psora crenata	(Taylor) Reinke
Psora decipiens	(Hedwig) Hoffm.
Psora icterica	(Mont.) Mull. Arg.
Psora montana	Timdal
Psora tuckermanii	R. Anderson ex Timdal
Pterygoneurum ovatum	(Hedw.) Dix.
Squamarina lentigera	(Weber) Poelt
Syntrichia caninervis	Mitt.
Syntrichia ruralis	(Hedw.) Web. & Mohr
Texosporium sancti-jacobi	(Tuck.) Nadv.
Thrombium epigaeum	(Pers.) Wallr.
Toninia ruginosa	(Tuck.) Herre
Toninia sedifolia	(Scop.) Timdal
Tortula inermis	(Brid.) Mont.
Trapeliopsis glaucopholis	(Nyl. ex Hasse) Printzen & McCune
Trapeliopsis granulosa	(Hoffm.) Lumbsch.
Trapeliopsis steppica	McCune & Camacho
Xanthoparmelia camtschadalis	(Ach.) Hale
Xanthoparmelia chlorochroa	(Tuck.) Hale
Xanthoparmelia neochlorochroa	Hale
Xanthoparmelia norchlorochroa	Hale
Xanthoparmelia wyomingica	(Gyeln.) Hale

Glossary

Acuminate: Gradually narrowing to a point, like a spade on a playing card

Adnate: Tightly adherent to surface

Alga (Algae): A simple plant composed of a single cell or a string of cells

Apothecium (Apothecia): A disk- or cup-shaped spore-producing organ

Appressed: Lying flat or pressed closely against the substrate

Areolate: Sharply divided into tile-like areolae

Areole (Areolae): A small, irregular, often angular patch of thallus delimited by cracks or chinks in the thallus surface

Ascus (Asci): The sac-like structure in which the spores are formed

Awn: Bristle or hair at a moss leaf tip, sometimes colored

Bryophyte: Member of phylum Bryophyta; refers collectively to mosses, liverworts and hornworts

Calyptra (Calyptrae): A thin hood covering the lid of the moss sporophyte capsule, usually falling at maturity

Capsule: Inflated structure at the end of the moss sporophyte containing spores

Chemical (or physical) crust: Inorganic crust caused by features such as platy soil surface particles or an accumulation of salts

Concolorous: Of the same color throughout

Cortex: The outermost layer of the thallus, which, if present, consists of hyphae which may appear either cellular or fibrous

Crenate: With a scalloped or round-toothed edge

Crustose: Crust-like lichens that are closely attached to their substrate and lack a lower cortex

Cucullate: Hood-shaped

Cyanobacteria: Simple photosynthesizing organisms that can fix atmospheric nitrogen and serve as a photobiont in lichen associations (also called blue-green algae)

Cyphella (Cyphellae): A pore recessed into the lower thallus surface where medullary hyphae protrude

Disk: The upper surface of a lichen apothecium enclosed by, but not including, the margin

Dioecious: Having male and female reproductive organs on separate plants

Dorsiventral: Flattened, with upper and lower surfaces

Ecotone: A transitional zone between two adjacent and distinct ecosystems.

Entire: Without teeth; more or less smooth on the margin

Epithecium (Epithecia): The uppermost portion of the hymenium formed by the tips of

the paraphyses, which are frequently expanded or branched, often pigmented and sometimes containing tiny granules

Epruinose: Lacking pruina

Exciple: The margin around the apothecial disk

Excurrent: Refers to a leaf mid-rib that runs out beyond the lamina of the leaf

Foliose: Having leaf-like lobes with distinct upper and lower surfaces

Fruticose: A shrubby or hair-like growth form attached only at the base or free growing and normally with no clearly distinguishable upper and lower surfaces

Gemma (Gemmae): Small asexual reproductive structure that detaches from the parent and develops into a new individual

Globose: Globe-shaped

Hymenia (Hymenium): The spore-bearing layer of fungal reproductive structures (ascoma)

Hypha (Hyphae): Fungal filaments, often modified and resembling round or angular cells

Hypothallus: The first and purely fungal (without photobiont) layer upon which an algae-containing thallus may develop, sometimes appearing as radiating, branched hyphae or hyphal bundles, often projecting beyond the thallus onto substrate

Hypothecium (Hypothecia): The tissue just below the hymenium (and subhymenium) but above the exciple, often with a distinctive color or texture but sometimes merging with the exciple

Imbricate: With overlapping layers

Immersed: Embedded in the substratum

Isidium (Isidia): Small, asexual reproductive structures on lichens that are minute and finger-like, covered with a cortex and contain the photobiont

Isidiod: Resembling isidia

Isidiate: Having isidia

Lamina (Laminae): The flattened, generally green, part of the leaf

Laminal: In the middle, or main part, of the thallus surface, rather than on the margins

Lecanorine: An apothecial margin which usually contains a photobiont and often resembles the thallus, but not the disk, in color and texture

Lecideine: An apothecial margin with no photobiont cells that often resembles the disk, but not the thallus, in color and texture

Lichen: Composite organism made up of a fungus and an alga, a cyanobacterium, or all three

Lid: Operculum; top part of moss capsule that comes off to release spores

Liverwort: A bryophyte belonging to the class Hepaticae, with flattened bodies that have distinct upper and lower surfaces

Lobate: Bearing lobes

Lobe: A flattened branch or projection

Lobulate: Having lobules

Lobule: Tiny, lobe-like, dorsiventral asexual reproductive outgrowths

Maculate: Spotted or blotched

Margin: Referring either to the outer edge of foliose or crustose lichen thalli or the outer boundary of apothecia

Medulla: Whitish (rarely orange or yellow) internal layer of most lichens, generally composed of loosely packed fungal hyphae

Mesic: Characterized by moist conditions, neither very wet nor very dry.

Monoecious: Having male and female reproductive organs on the same plant

Moss: Non-vascular plant in the division Bryophyta which has leaves attached in a whorl about the stem and long-lasting sporophyte with spores that ripen after elongation of the seta

Neck: The sterile basal portion of the capsule between the spore sac and the summit of the seta, often narrowed

Oblong: Proportioned about 1:3-6 with the margins more or less parallel; rectangular but ends not necessarily squared off

Ovate: Egg-shaped with the larger end at the base

Obovate: Inversely ovate, with the narrower end at the base

Ostiole: A small opening or pore

Papilla (Papillae): Minute protuberance on the surface of a cell

Papillose: Having papillae

Paraphysis (Paraphyses): A sterile filament (sometimes branched, attached at the base and free at the summit) found in amongst the asci in the hymenium

Patent: Spreading from the stem at an angle of 45° or more

Percurrent: Extending to the apex of a leaf

Perianth: Sterile tubelike tissue that surrounds the sporophyte

Peristome: The fringe of teeth surrounding the mouth of the capsule, becoming exposed after the lid falls

Perithecium (Perithecia): A globose or flask-shaped fruiting body (ascoma) completely enclosed with protective sterile tissue and with an opening pore at the tip

Photobiont: The photosynthetic component in a lichen, either algae in the strict sense (e.g., green algae) or cyanobacteria (blue-green algae), or both

Podetium (Podetia): The upright, hollow stalk formed by an elongated apothecium

Pruina: Powdery frost-like deposit, typically composed of calcium oxalate

Pruinose: Having a frosted appearance caused by a deposit of pruina

Pseudocyphella (Pseudocyphellae): A break or opening in the cortex where medullary hyphae protrude; it may be round, irregular, angular, or a minuscule pore

Pycnidium (Pycnidia): Minute, flask-shaped, fungal fruiting body

Recurved: Curved downward or backward

Rhizine: Root-like hyphae on the lower side of a foliose lichen thallus

Rhizoid: Root-like structure on the lower side of a moss

Rosette: A flower-like pattern arrayed around a common point of attachment

Sessile: Attached directly to the thallus surface without a stalk of any kind

Seta (Setae): The stalk of a moss sporophyte which supports the capsule

Simple: Not divided; unbranched

Soralium (Soralia): An area of the thallus in which the cortex has broken down or cracked and soredia are produced

Soredium (Soredia): Asexual reproductive structure that is powdery to granular, not covered with a well-defined cortex, and contains both algal (photobiont) and fungal (mycobiont) components

Sorediate: Having soredia

Spores: Microscopic reproductive bodies released from the sporophyte capsule of a moss or liverwort, or from the apothecia of a lichen

Sporophyte: Spore-producing plant structure or phase of a moss or liverwort, consisting of a foot, a seta, and a capsule, but not leaves or rhizoids

Spot test: Tests for color reactions obtained by applying a liquid chemical reagent to a lichen

Squamule: Small flakes or scales of a lichen, lifting from the substrate, at least at the edges, often rounded, ear-like, or lobed

Squamulose: Composed of or characterized by having squamules—an intermediate growth form between crustose and foliose

Squarrose: Branching at right angles from a single main axis, like a bottlebrush

Sterile: Without sexual reproductive structures

Stratified: Differentiated into layers

Subfoliose: Almost foliose, pertaining to the overall growth form of a crustose thallus that has marginal lobes showing some tendency to curve upwards

Terete: Circular in cross-section—cylindrical and smooth

Thallus (Thalli): The vegetative body consisting of both algal and fungal components, not differentiated into a stem and leaves

TLC: Thin layer chromatography—a technique used to separate chemical compounds

Additional resources

Websites

Biological Soil Crusts

J. Belnap, U. S. Geological Survey
http://www.soilcrust.org/

Bryophyte Flora of North America

Missouri Botanical Garden
http://www.mobot.org/plantscience/BFNA/bfnamenu.htm

Common Wildflowers, Lichens, and Mosses of the Shrub-steppe

Pacific Northwest National Laboratory
http://ecology.pnl.gov/Gallery/Wildfl.asp

Cyanosite: A Webserver for Cyanobacterial Research

M. A. Schneegurt, Purdue University
http://www-cyanosite.bio.purdue.edu/

eFloras

Missouri Botanical Garden
www.eFloras.org

Field Guide to Selected Rare Plants of Washington

Washington State Department of Natural Resources
http://www.dnr.wa.gov/nhp/refdesk/fguide/htm/fgmain.htm

Internet Resources for Bryologists and Lichenologists

American Bryological and Lichenological Society
https://mywebspace.wisc.edu/jpbennet/web/abls/resources.html

Key to the Lichen Genera of the Pacific Northwest

B. McCune, Oregon State University
http://oregonstate.edu/~mccuneb/pnw.PDF

Lichen Herbarium

Arizona State University, School of Life Science
http://nhc.asu.edu/lichens/flora/publications.jsp

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http://www.lichen.com

Mosses, Lichens, and Liverworts of the Northwoods

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http://www.rook.org/earl/bwca/nature/moss

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L. R. Stark and J. R. Shevock, Nevada Natural Heritage Program
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The Plants Database

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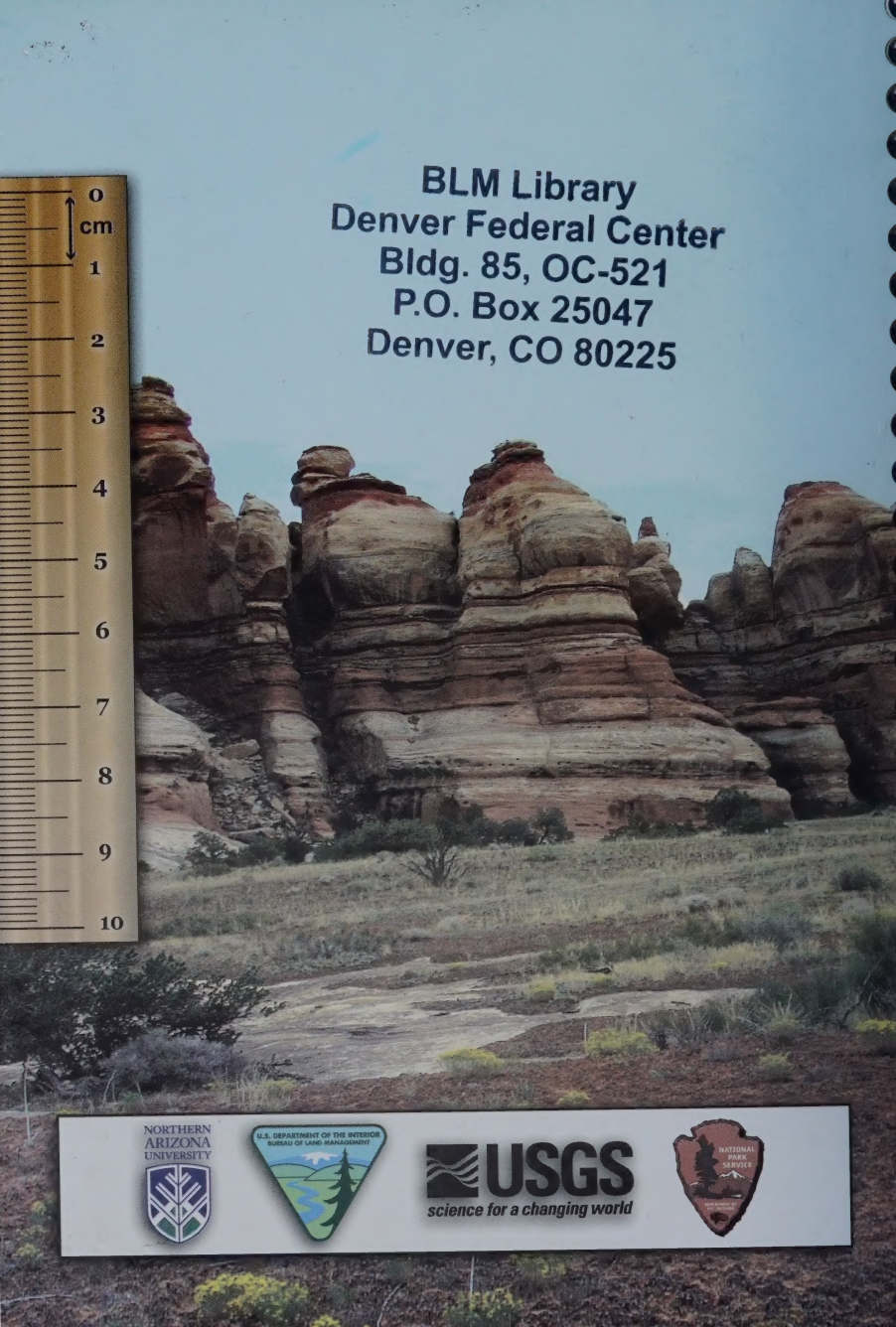
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